# DOCUMENT RESUME

ED 216 117 CE 032 070

| | |
|---|---|
| AUTHOR | Butler, Raymond H.; And Others |
| TITLE | Electrical Technology. Post Secondary Curriculum Guide. |
| INSTITUTION | Georgia Univ., Athens. Div. of Vocational Education. |
| SPONS AGENCY | Georgia State Dept. of Education, Atlanta. Office of Adult and Vocational Education. |
| PUB DATE | 81 |
| NOTE | 381p. |
| EDRS PRICE | MF01/PC16 Plus Postage. |
| DESCRIPTORS | Behavioral Objectives; Course Descriptions; Electrical Occupations; *Electricity; *Electronics; *Electronic Technicians; Facility Guidelines; Learning Activities; Postsecondary Education; State Curriculum Guides; *Technical Education |
| IDENTIFIERS | *Electrical Technology; Georgia |

ABSTRACT

This curriculum guide provides a model for organizing vocational instructional content for a postsecondary electrical technology program. It is divided into six sections. Section 1 overviews the philosophies, purposes, and goals for vocational education in Georgia. Contents of section 2 include a discussion of employability skills, description of the occupational field, program objective containing specific occupational titles, description of occupational exit points, and task listing by Dictionary of Occupational Titles code. Section 3 contains the unit guides for the 10 duties and 99 tasks included in the course. Each task is presented on a separate page and contains the following information: task, performance objective, instructional activities, suggested instructional materials, evaluation, and class and lab hours. Topics covered include introduction to electricity/electronics, electrochemical action and direct current (DC), alternating current (AC), measuring instruments, protective devices, DC equipment and controls, singlephase motors, polyphase systems, AC control equipment, and electrical troubleshooting. Section 4 provides suggested methods of structuring the curriculum. Suggested ways of recording and documenting student progress are presented in section 5. Section 6 contains facility layouts. Appendixes include instructional resource matrix, unit guide references, additional instructional resources, information on working with special needs students, and definitions of terms. (YLB)

***********************************************************************
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
***********************************************************************

8113303

ED216117

# ELECTRICAL TECHNOLOGY

## Post Secondary

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

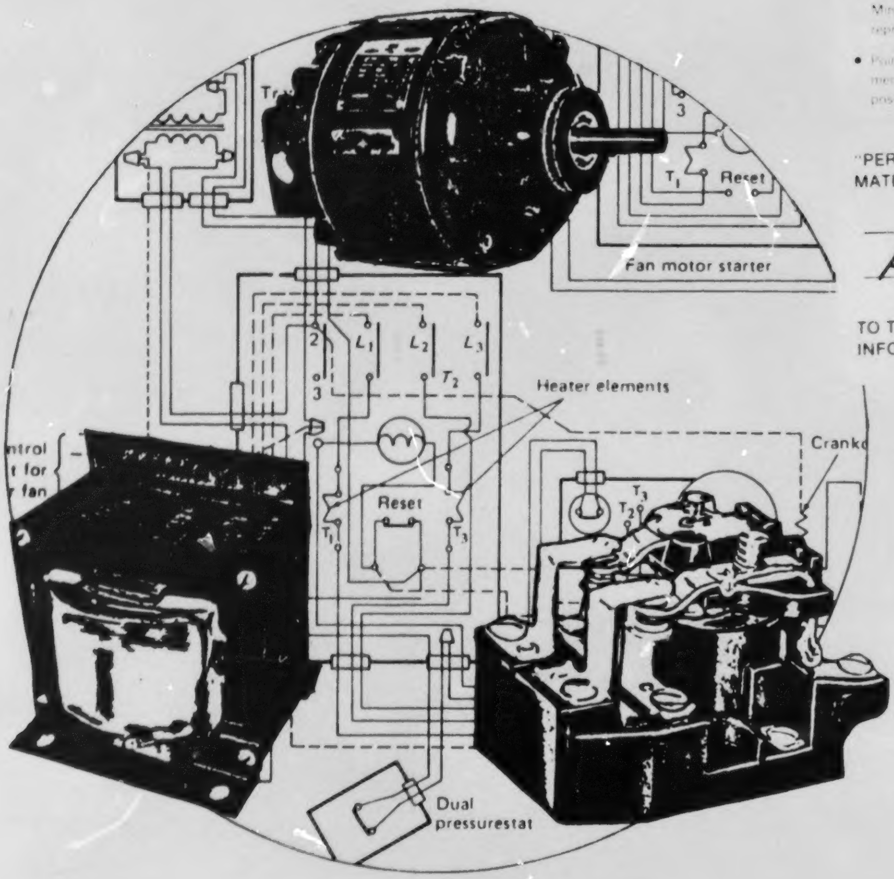
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

A. Moughon

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."


Tr
3
T1
Reset
Fan motor starter
2
L1
L2
L3
3
T2
Heater elements
ntrol
t for
r fan
Reset
T1
T3
T3
T2
Crankc
Dual
pressurestat

CE 032 070

## CURRICULUM GUIDE

## Georgia Department of Education

# ELECTRICAL TECHNOLOGY

Developed Under Contractual Agreement with

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1981

# ELECTRICAL TECHNOLOGY

Developed By

The University of Georgia

Under the Direction of

Dr. Paul Scott

Vocational Education Materials Center

Division of Vocational Education

College of Education

Dr. George L. O'Kelley, Jr.

Division Chairman

# ELECTRICAL TECHNOLOGY

## DEVELOPERS

| | |
|---|---|
| Raymond H. Butler | Principal Developer/Writer |

## CONTRIBUTORS

| | |
|---|---|
| Rhonda Hefner Packer | Editor/Production |
| C. Paul Scott | Writer, Special Needs |
| Calvin Pelfrey | Cover Design and Illustrations |

## REVIEW PANEL

| | |
|---|---|
| C.G. Gerrard | Augusta Area Technical School |
| K.E. Kent | DeKalb Area Vocational Technical School |
| Bill Kesler | North Georgia Tech |

## TYPISTS

| | |
|---|---|
| Teresa Whitehead | Project Secretary |
| Gerry DeWald | Typist |
| Janie Duceatt | Typist |
| Marchia Elder | Typist |
| Carolyn Graham | Typist |
| Janice Martin | Typist |
| Gay Weaver | Typist |
| Frankie Wright | Typist |

**Division of Vocational Education**
**College of Education**
**University of Georgia. Athens, Ga.**

## POLICIES AND PROCEDURES FOR THE CENTER

## PURPOSE OF THE CENTER

The Vocational Education Materials Center functions within the division of Vocational Education, University of Georgia. This Center operates under grants from the U.S. Office of Education, and the Georgia State Department of Education with the support of the College of Education. The Center is comprehensive in its commitment and approach to the development and dissemination of materials in the broad field of Vocational Education.

The purpose of the Center is to increase the capability of Georgia's delivery system for Vocational Education. Specifically, the Center is committed to:

1. Develop materials to assist in the implementation of proposed curricula and to enhance the teaching Vocational Education.
2. Conduct and report curriculum research related to Vocational Education.
3. Provide a production and dissemination center to Vocational Education materials.
4. Provide direct experiences in curriculum development and diffusion for advanced graduate stduents.
5. Enable faculty members to participate in the development and implementation of a variety of curriculum materials.

Dr. G.L. O'Kelley, Jr.; Chairman
Division of Vocational Education
628 Aderhold Hall
University of Georgia
Athens, Georgia 30602

ELECTRICAL TECHNOLOGY TABLE OF CONTENTS

SECTION I: PHILOSOPHY, PURPOSE AND OBJECTIVES (Pink).........I-1

State.........................................................I-5

Local.........................................................I-7

SECTION II: PROGRAM DESCRIPTION AND RELATED INFORMATION (Blue)..............................II-1

Employability Skills..................................II-5

Description of Occupational Field.........................II-7

Electrical Technology Program Objective..................II-12

Definition of D.O.T. Code................................II-13

Description of Occupational Exit Points..................II-14

Task Listing by D.O.T. Code..............................II-18

SECTION III: UNIT GUIDES (Gold)..........................III-1

Unit Guide Description...................................III-5

Electrical Technology Task Index.........................III-7

Unit Guides.............................................III-11

SECTION IV: CURRICULUM STRUCTURE AND COURSE OUTLINE (Green).................................IV-1

Introduction to the Curriculum Structure..................IV-5

Electrical Technology Curriculum Structure...............IV-6

Introduction Electrical Technology Exit Points...........IV-7

Introduction to the Course Outline.......................IV-10

SECTION V: STUDENT RECORDS (Yellow).......................V-1

Records Management............................................V-5

Instructions..................................................V-6

Competency Checklist..........................................V-7

Certificates of Competency...................................V-11

SECTION VI: FACILITIES (Pink) .......... VI-1

Group Instruction Facilities .......... VI-7

Individualized Instruction Facilities .......... VI-9

APPENDIX A: RESOURCES (Blue) .......... A-1

Instructional Resource Matrix .......... A-4

Unit Guide References .......... A-22

Additional Instructional Materials .......... A-23

Resource Addresses .......... A-24

APPENDIX B: SPECIAL NEEDS (Green) .......... B-1

APPENDIX C: DEFINITION OF TERMS (Yellow) .......... C-1

## PURPOSE AND UTILIZATION OF THE CURRICULUM GUIDES

The purpose of this curriculum guide is to provide a suggested model for organizing vocational instructional content. In many cases, more material is available than may be needed, there fore, an instructor will need to adapt the content to meet his/her program needs.

While the guide is primarily oriented towards the classroom, whether as a primary resource or as a supplement to other teaching materials; it may also assist administrators, counselors and lay people involved in local school systems. The following outline provides an overview of the various ways these groups may utilize the curriculum guides.

a) Vocational teachers.

1. Provide a guide for organizing their program of instruction,
2. Assist in establishing program objectives,
3. Serve as a curriculum materials resource guide,
4. Improve communications with employers and advisory committees
5. Facilitate competency based instruction,
6. Facilitate either group or self-paced instruction,
7. Include content by quarter and semester,
8. Cross-reference with existing state developed instructional materials (PLACE packages and post secondary I.I.).

b) Vocational supervisors and administrators.

1. Assist in defining the scope and content of their programs,
2. Provide a means to improve curriculum management functions,
3. Serve as a guide for admissions and job placement functions,
4. Improve communications with employers and advisory committees.

c) Counseling and guidance staff.

1. Provide a data base for counseling and guidance personnel,
2. Identify student exit points (Career Options),
3. Serve as guide for admissions and job placement,

4. Correlate with new State Board of Education graduation requirements,
5. Provide specific content sequencing by quarter and semester for student scheduling,
6. Provide (a) curriculum options for the disadvantaged handicapped student, (b) curriculum modifications for SPECIAL NEEDS students, (c) typical admission requirements for regular and SPECIAL NEEDS students.

(d) Local Curriculum Coordination Committees.

1. Serve as a guide in working out articulation arrangements,
2. Improve definitions of the relationship between secondary clusters and post secondary specialized programs.

Vocational teachers, supervisors and administrators, counseling and guidance staff and local curriculum coordination committees will be primary users of this guide, however, the use of the guide is not limited to these groups, but by any and all groups directly related in designing a vocational curriculum.

# -Foreword-

It has been the privilege of the Division of Vocational Education, University of Georgia, to participate in the development of 48 curriculum guides for Georgia vocational education programs. This work was sponsored by the Division of Program Development, Office of Vocational Education, State Department of Education. The completion of these guides meets a long standing need to provide a comprehensive curriculum overview of the vocational education programs available in Georgia schools. This developmental activity involved one of the largest professional staffs ever assembled for such work. Numerous teachers, teacher educators and state staff members have either written parts of the guides or served on the field review teams. These professionals were supported by a myriad of technical people and a host of typists who literally worked from dawn to dusk to ensure that the guides were produced in a timely fashion.

Be assured that this guide is not intended to be your curriculum or the curriculum of any school. The purpose of this project staff, and I am sure of the state OVE staff, is to offer a guide with supporting resources and teaching ideas from which the vocational instructor can extract a curriculum that meets local needs. The guide, however, does simplify curriculum decisions concerning sequencing and the selection of resources and media support.

The Task Linkage Project and appropriate V'TECS catalogs were used as the beginning point for this guide and all of the others. To assure that these task listings were directly related to Georgia vocational education programs and industry, they were subjected to additional study and review by appropriate teachers.

At some point in the future, this guide will need to be revised. To ensure that such a revision truly reflects the needs of Georgia's vocational education programs, the developers need your reactions, comments and ideas. We will also be interested in how you use this guide. Let us hear from you.

Paul Scott
Curriculum Guide Projects I & II

# SECTION I

## PHILOSOPHY, PURPOSE & OBJECTIVES

# SECTION I

## Section I Content List

State Philosophy and Goals
Local Philosophy and Goals

Section I provides an overview of the philosophies, purposes and goals for vocational education in the State of Georgia. These are applied to vocational education at the postsecondary level, however, it is recognized that more specific philosophies, purposes and goals will be applicable depending on the character of the local program.

## VOCATIONAL EDUCATION IN GEORGIA

### A. PHILOSOPHY

The Georgia Board of Education perceives vocational education as a vital component in the education of the young and adult citizens of this State. Appropriate programs of vocational education and ancillary services should be made readily available to individuals in middle schools, vocational divisions of junior colleges, vocational centers, the Quick Start program and other adult programs designed to train or retrain workers for useful and satisfying employment.

Special services and assistance must be provided to those who need it in order to participate or benefit from vocational education. This includes women, minorities, the displaced homemaker and other displaced workers, those with limited English-speaking ability, the disadvantaged and the handicapped.

Since men and women spend the greater part of their lives at some form of work, the State should provide opportunities for all its citizens to develop the knowledge, skills and attitudes necessary for them to secure personally satisfying and socially useful employment.

### B. PURPOSE

The purpose of vocational education shall be to improve the economic well-being of Georgia citizens by preparing individuals, through organized learning experiences, to select, obtain and advance in recognized occupations.

# POSTSECONDARY VOCATIONAL EDUCATION

## A. PURPOSE

The purpose of postsecondary vocational-technical education in Georgia is to improve the economic well-being of adult citizens by providing access to high quality vocational-technical training for skilled and semi-skilled occupations, for improvement of existing skills or for retraining in a new occupation.

## B. OBJECTIVES

1. To provide vocational-technical education programs and ancillary services commensurate with the needs and interests of students and available job opportunities.

2. To provide vocational-technical education programs which are current with the state-of-the-art, competency-based, and offer multiple exit points to accommodate the students' occupational objectives.

3. To provide vocational-technical education programs which are articulated with available high school counterparts, to facilitate an easy transition from secondary to postsecondary levels without loss of credit.

4. To provide vocational-technical education programs such that 75% of those individuals who leave or complete a program of occupational preparation will find employment in the field, or a related field, for which trained.

5. To provide those guidance, counseling, financial aid, evaluative, job placement, remedial and other supportive programs and services needed by students to enroll, complete a program and become, or remain, employable in a skilled or semi-skilled occupation.

6. To provide needed assistance to special populations to include women, minorities, limited English-speaking, the displaced homemaker and other displaced workers, the disadvantaged and the handicapped.

7. To provide vocational-technical education programs for full-time and part-time students on campus during the day as well as the evening hours, and to provide appropriate programs for full-time and part-time students off campus in businesses and industries, comprehensive high schools and other locations within the respective schools' service areas.

8. To serve as a center for the delivery of postsecondary and adult vocational-technical education programs and services for the community and assigned service area.

# STATEMENT OF LOCAL SYSTEM PHILOSOPHY, PURPOSE AND OBJECTIVES FOR VOCATIONAL EDUCATION

(This page is intentionally left blank so that local systems may insert their copy of philosophy, purpose and goals for vocational education.)

# SECTION II

## PROGRAM DESCRIPTION & RELATED INFORMATION

# SECTION II

## Section II Content List

Employability Skills
Electrical Technology Occupational Description
Electrical Technology Program Objective
Definition of the D.O.T. Code
Description of Electrical Technology D.O.T.
Task Listing by D.O.T. Code

The major goal of vocational education in Georgia is to prepare individuals, through organized learning experiences, to select, obtain and advance in recognized occupations. Section II provides an overview of employability skills that are desirable in any occupation and relates their significance to the specific occupational area of Electrical Technology.

The Electrical Technology Program Objective contains the specific occupational titles. These occupational titles are further explained in the description of the occupational exit points and task listing. The concentration of the program is based on these tasks.

## EMPLOYABILITY SKILLS

Employability skills exert a great deal of influence on a person's ability to get and keep a job. Surveys indicate that more people lose their jobs because of poor attitudes toward their job than for lack of job skills. For this reason it is important that information concerning the following employability skills be provided as an ongoing part of the program.

1. Getting a job
    a. Filling out job applications
    b. Developing a resume
    c. Preparing for a job interview
2. Keeping a job
    a. Be on time and regular in attendance
    b. Maintain a fair share of the work-load
    c. Work without supervision
    d. Meet production schedules
    e. Properly care for and use equipment
    f. Dress appropriately for the job
    g. Maintain good personal hygiene
    h. Develop and maintain good communication with supervisors and co-workers

A recent study sponsored by the Illinois Department of Adult, Vocational and Technical Education and conducted by the University of Illinois, "Survival Skills: Mastering the Human Aspects of Work", has identified twelve topics that might be developed into instructional modules for teaching occupational survival skills. The author, Robert E. Nelson, outlines these topics listed below and on the next page, each followed by a general objective which indicates the relationship between the topic and the survival skills required to maintain a job.

*"1. Working in an Organization: To familiarize students with the reasons for the formation of organizations and the common characteristics of organizations.
2. Understanding Self and Others: To have students develop insights into causes of human behavior and learn to interpret their own behavior and the behavior of other.

3. Motivation for Work: To have students develop and understanding of motivations into the work they perform.
4. Interpersonal Relations: To have students develop concepts and skills in interpersonal relations and apply them to work situations.
5. On-the-Job Communication: To have students understand the importance of effective communication and learn ways of communicating effectively on the job.
6. Using Creativity on the Job: To make students aware of their creative potential and to practice using their creative ability in hypothetical on-the-job situations.
7. Authority and Responsibility: To have students develop an understanding of the concepts of authority, power, influence, and responsibility as they apply to work situations.
8. Problem Solving: To have students develop skill in applying problem solving to their work.
9. Coping with Organizational Change: To make students aware of the process of organizational change and the techniques for coping with organizational change.
10. Coping with Organizational Conflict: To make students aware of the sources and types of conflicts encountered on the job and recognize ways of coping with conflicts in an organization.
11. Leadership: To have students recognize the need for leadership in work groups and increase their understanding of the leadership role in work situations.
12. Adapting and Planning for the Future: To have students develop perspectives of work in the future and the ability to plan for anticipated changes in their work roles."

---

*Abstracted from the article, "Survival Skills: Mastering the Human Aspects of Work," by Robert E. Nelson, *American Vocational Journal*, November 1977.

# ELECTRICAL TECHNOLOGY*

## Nature of Work

Maintenance electricians keep lighting systems, transformers, generators, and other electrical equipment in good working order. They also install new electrical equipment.

Duties vary greatly, depending on where the electrician is employed. Electricians who work in large factories may repair particular items such as motors and welding machines. Those in office buildings and small plants usually fix all kinds of electrical equipment. Regardless of location, electricians spend much of their time doing preventive maintenance--periodic inspection of equipment to locate and correct defects before breakdowns occur. When trouble occurs, they must find the cause and make repairs quickly to prevent costly production losses. In emergencies, they advise management whether continued operation of equipment would be hazardous.

Maintenance electricians make repairs by replacing items such as a lamp, fuse, switch, or wire. When replacing a wire, they first make sure the power is off. Workers then pull the old wire from the conduit (a pipe or tube) and pull the new wire through to replace the old. Once the new wire is connected, they test to make sure the circuit is complete and functioning properly.

Maintenance electricians sometimes work from blueprints, wiring diagrams, or other specifications. They use meters and other testing devices to locate faulty equipment. To make repairs they use pliers, screwdrivers, wirecutters, drills, and other tools.

During a single day, an electrician may repair equipment both in a clean, air-conditioned office and on a factory floor, surrounded by the noise, oil, and grease of machinery. Electricians often climb ladders or work on scaffolds in awkward or cramped positions.

Because maintenance electricians work near high-voltage industrial equipment, they must be alert and accurate. Errors in wiring installations could endanger both the electrician and other employees. Safety principles, which are a part of all electrician training programs, have reduced the frequency of accidents. Electricians are taught to use protective equipment and clothing, to respect the destructive potential of electricity, and to fight small electrical fires.

## Places of Employment

An estimated 300,000 maintenance electricians were employed in 1978. More than half of them worked in manufacturing industries, large numbers worked in plants that make automobiles, machinery, chemicals, aluminum, and iron and steel. Many maintenance electricians also were employed by public utilities, mines, railroads, and Federal, State, and local governments.

Maintenance electricians are employed in every State. Large numbers work in heavily industrialized States such as California, New York, Pennsylvania, Illinois, and Ohio.

## Training, Other Qualifications, and Advancement

Most maintenance electricians learn that trade on the job or through formal apprenticeship programs. A relatively small number learn the trade in the Armed Forces. Training authorities generally agree that apprenticeship gives trainees more thorough knowledge of the trade and improved job opportunities during their working life. Because the training is comprehensive, people who complete apprenticeship programs may qualify either as maintenance or construction electricians. Apprenticeship usually lasts 4 years, and consists of on-the-job training and related classroom instruction in subjects such as mathematics, electrical and electronic theory and blueprint reading. Training may include motor repair, wire splicing, installation and repair of electronic controls and circuits, and welding and brazing.

Although apprenticeship is the preferred method of training, many people learn the trade informally on the job by serving as helpers to skilled maintenance electricians. Helpers begin by doing simple jobs such as replacing fuses or resetting switches and, with experience, advance to more complicated jobs such as splicing and connecting wires. They eventually get enough experience to qualify as electricians. This method of learning the trade, however, may take considerably longer than 4 years.

Persons interested in becoming maintenance electricians can obtain a good background by taking high school or vocational school courses in electricity, electronics, algebra, mechanical drawing, shop and science. To qualify for an apprenticeship program, an applicant must be at least 18 years old and usually must be a high school or vocational school graduate with 1 year of algebra.

Although physical strength is not essential, manual dexterity, agility, and good health are important. Good color vision is necessary because electrical wires frequently are identified by color.

All maintenance electricians should be familiar with the National Electric Code and local building codes. Many cities and counties require maintenance electricians to be licensed. Electricians can get a license by passing an examination that tests their knowledge of electrical theory and its application.

Some maintenance electricians become supervisors. Occasionally, they advance to jobs such as plant electrical superintendent or plant maintenance superintendent.

## Employment Outlook

Employment of maintenance electricians is expected to increase faster than the average for all occupations through the 1980's. Growth will stem from increased use of electrical and electronic equipment by industry. In addition to new jobs arising from the increased need for these workers, a few thousand openings will arise each year to replace experienced electricians who retire, die, or transfer to other occupations.

Growth in the number of job openings is expected to be fairly steady in the years ahead since the demand for maintenance electricians is not very sensitive to ups and downs in the economy. At times when construction activity is depressed, however, beginners may face competition for job openings because some unemployed construction electricians apply for the openings.

## Related Occupations

Maintenance electricians combine manual skill and a knowledge of electricity to clean, repair, and replace electrical devices. Other workers who have similar skills are air-conditioning installers, construction electricians, electrical appliance repairers, electronics mechanics, elevator constructors, and line and cable installers.

## Sources of Additional Information

General information in careers for electricians is available from:

International Brotherhood of Electric Workers
1125 15th Street N.W.
Washington, D.C. 20005

National Electrical Constructor Association
7315 Wisconsin Avenue N.W.
Washington, D.C. 20014

National Joint Apprenticeship and Training
Committee for the Electrical Industry
9700 E. George Palmer Highway
Lanham, MD 20801

---

*Occupational Outlook Handbook, 1980 ed.

# ELECTRICAL TECHNOLOGY PROGRAM OBJECTIVE

Given appropriate instruction, as suggested by this guide, a student completing the program should demonstrate entry level skills in Electrical Technology in the areas of knowledge, theoretical stucture, tool usage, diagnostic ability, related supportive skills and occupational survival skills.

As the student progresses through the program, sufficient competencies will be acquired to enable the student to enter the occupational field at the following D.O.T. Codes.*

| | |
|---|---|
| Electric Meter Installer | (D.O.T. Code 821.361-014) |
| Power Transformer Repairer | (D.O.T. Code 821.361-034) |
| Electric Motor Analyst | (D.O.T. Code 721.261-010) |
| Electric Motor Assembler and Analyst | (D.O.T. Code 721.281-014) |
| Electric Motor Repairer | (D.O.T. Code 721.281-018) |
| Electrician | (D.O.T. Code 824.261-010) |
| Electrical Technician | (D.O.T. Code 003.161-010) |

---

***Dictionary of Occupational Titles*, 1977 ed.

# DEFINITION OF D.O.T. CODE*

As a result of technological, economic and sociological influences, nearly every job in the economy is performed slightly differently from any other job. Every job is also similar to a number of other jobs. In order to look at the millions of jobs in an organized way, job titles are designated a 9-digit occupational code. Each set of three digits in the D.O.T. Code has a specific purpose or meaning that differentiates it from all other codes.

The first three digits of the D.O.T. Code identify a particular occupational group. In the code 652.382-010, the first digit indicates an occupational category. The second digit refers to a division within the occupational category. The third digit defines a specific occupational group within a division.

The middle three digits of the D.O.T. Code 652.382-010 are the worker function rating of the tasks performed in the occupation. Every job requires a worker to function, to some degree, in relation to data, people and things. A separate digit expresses the worker's relationship to each of these three groups. Worker functions involving more complex responsibility and judgment are assigned lower numbers while functions which are less complicated have high numbers.

The last three digits of the D.O.T. Code 652.382-010 indicate the alphabetical order of titles within 6-digit code groups. They serve to differentiate a particular occupation from all others. A number of occupations may have the same first six digits, but no two D.O.T. Code can have the same nine digits.

*Dictionary of Occupational Titles, 1977 ed.

# DESCRIPTION OF OCCUPATIONAL EXIT POINTS*

## 821.361-014 ELECTRIC-METER INSTALLER (light, heat, & power)

Installs, disconnects, removes, and reconnects electric power meters used to record current consumption of residential, commercial, and industrial customers: Splices and connects covered insulated cable to bus bar in pull box or on switchboard. Mounts meter, and other electric equipment for high load installations, such as time clocks, transformers, and circuit breakers, on racks or wall, using electrician handtools. Installs and connects cable from pull box to meter socket or transformer. Attaches color-coded wires from current transformer to test blocks and from test blocks to meter terminals for testing purposes. Tests meter for current flow and recording of current consumption. Disconnects and seals meter on cut-off order or removes seal and reconnects meter on cut-in orders. Removes, replaces, and reconnects meters when current consumption is too high for existing installations. Installs temporary service meter for recording current consumption during construction. Splices and connects jumper cables from current transformer onto bus bar on switchboard to provide temporary power for customer during change of meter and cables or when customer's service equipment is defective. Records meter and installation data on meter cards, work orders, and field service orders. Locates, diagnoses, and clears electrical trouble on customers' premises. Performs minor repairs and changes faulty or incorrect wiring on customers' premises. May be designated according to specialty as METER INSTALLER-AND-REMOVER (light, heat, & power).

## 821.361-034 POWER-TRANSFORMER REPAIRER (light, heat & power)
transformer assembler

Repairs power transformers used in electric generating stations and substations to step-up voltage of current being fed out over high-voltage powerlines or to step-down voltage of incoming current prior to being fed to lower voltage distribution lines or electric equipment: Drains and filters transformer oil. Loosens bolts to free transformer cover, laminations, coils, and other internal and external parts. Signals BRIDGE-OR-GANTRY-CRANE OPERATOR (any ind.) to raise heavy transformer components and subassemblies. Dismantles lamination assembly preparatory to cleaning and inspection. Conveys defective coils to TRANSFORMER-COIL WINDER (light, heat & power) for rewinding. Climbs into transformer case, cleans inner surfaces with scrapers and solvent, and examines case for defects, such as cracked weldments. Reassembles transformer, using new and reconditioned parts as specified. Operates pump to fill reassembled transformer with oil. May work at site of transformer installation. May wind replacement coil.

721.261-010 ELECTRIC-MOTOR ANALYST (any ind.)

Determines causes of failures in electric motors, following drawings and specifications and using handtools and electrical test meters: Dismantles motor, using handtools. Examines bearings, brackets, and other parts for wear and damage. Tests armature and stator for shorted, grounded, or broken wires, using electrical test meters. Lists causes of motor failures and repairs required and reports adjustments and repair requirements to repairer. May repair mechanical parts and reassemble motor, using handtools and power tools. May rebuild motor.

721.281-014 ELECTRIC-MOTOR ASSEMBLER AND TESTER (any ind.)
motor assembler

Assembles and adjusts repaired electric motors to meet specified ratings, using handtools and electrical meters: Cleans motor parts with gasoline. Repairs or replaces damaged parts and assembles motor, using handtools. Measures velocity, horsepower, and current consumption of motor, using electrical meters and mechanical testing devices. Adjusts motor to ratings specified on motor nameplate. May ream and fit motor bearings and grind, turn, and polish parts, using machine tools, such as grinder and lathe.

721.281-018 ELECTRIC-MOTOR REPAIRER (any ind.)

Repairs electric motors, generators, and equipment, such as starting devices and switches, following schematic drawings, and using handtools, coil-winding machines, power tools, and test equipment: Disassembles and removes armature, stator, or rotor from housing. Examines coil connections for broken or defective wiring. Tests coils, armatures, stator, rotor, and field coils for continuity, shorts, and grounds and insulation resistance, using test lamp, ammeter, and ohmmeter. Cuts out or removes defective coils and removes insulation from core slots. Cuts and forms insulation and inserts insulation into armature, rotor, or stator slots. Rewinds coils on core while in slots manually or makes replacement coils, using coil-winding machine. Installs and alines prewound coils in slots, using hammer, drift, or mallet. Replaces defective coil leads and solders connections of coils in specified sequence. Examines bearings, shafts, and other moving parts for excessive wear or defects. Refaces commutators and machine parts to specified tolerances, using machine tools. Assembles and tests motor for specified performance. May be designated according to size of motor repaired as FRACTIONAL-HORSEPOWER MOTOR REPAIRER (any ind.); equipment repaired as DYNAMOTOR REPAIRER (any ind.); or part repaired as ARMATURE STRAIGHTENER (elec. equip.); COIL-CONNECTOR REPAIRER (elect. equip.); COMMUTATOR REPAIRER (any ind.); FIELD-COIL REPAIRER (elec. equip.); STATOR REPAIRER (any ind.).

### 824.261-010 ELECTRICIAN (any ind.) wirer

Plans layout, installs, and repairs wiring, electrical fixtures, apparatus, and control equipment: Plans new or modified installations to minimize waste of materials, provide access for future maintenance, and avoid unsightly, hazardous, and unreliable wiring, consistent with specifications and local electrical codes. Prepares sketches showing location of wiring and equipment, or follows diagrams or blueprints, insuring that concealed wiring is installed before completion of future walls, ceilings, and flooring. Measures, cuts, bends, threads, assembles, and installs electrical conduit, using such tools as hacksaw, pipe threader, and conduit bender. Pulls wiring through conduit, assisted by ELECTRICIAN HELPER (any ind.). Splices wires by stripping insulation from terminal leads with knife or pliers, twisting or soldering wires together, and applying tape or terminal caps. Connects wiring to lighting fixtures and power equipment, using handtools. Installs control and distribution apparatus, such as switches, relays, and circuit-breaker panels, fastening in place with screws or bolts, using handtools and power tools. Connects power cables to equipment, such as electric range or motor, and installs grounding leads. Tests continually of circuit to insure electrical compatibility and safety of components, using testing instruments, such as ohmmeter, battery and buzzer, and oscilloscope. Observes functioning of installed equipment or system to detect hazards and need for adjustments, relocation, or replacement. May repair faulty equipment or systems [ELECTRICAL REPAIRER (any ind.)]. May be required to hold license. May cur and weld steel structural members, using flamecutting and welding equipment. May be designated according to work location as MINE ELECTRICIAN (mining & quarrying).

### 003.161-010 ELECTRICAL TECHNICIAN (profess. & kin.)
electrical-laboratory technician

Applies electrical theory and related knowledge to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial or commercial plants and laboratories. Assembles and tests experimental motor-control devices, switch panels, transformers, generator windings, solenoids, and other electrical equipment and components according to engineering data and knowledge of electrical principles. Modifies electrical prototypes to correct functional deviations under direction of ELECTRICAL ENGINEER (profess. & kin.). Diagnoses cause of electrical or mechanical malfunction or failure of operational equipment and performs preventative and corrective maintenance. Develops wiring diagrams, layout drawings, and engineering specifications for system or equipment modifications or expansion, directs personnel performing routine installation and maintenance duties. Plans, directs, and records periodic electrical testing, and recommends or initiates modification or replacement of equipment which fails to meet acceptable operating standards.

---

*Dictionary of Occupational Titles, 1977 ed.

## TASK LISTING BY D.O.T. CODE

In this section the occupational exit points from the curriculum are cross referenced with the tasks which are required for employment in each job title. On the line following each task an x appears in the column of each job title to which to task applies. All the tasks listed in this matrix are taught in the curriculum presented in this guide. A detailed treatment of each task appears in the Unit Guides section of this curriculum guide.

# TASK LISTING BY DOT CODE

## ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| TASK NO. | TASK NAME | DOT DESCRIPTIONS: Electric Meter Installer<br>DOT NO.: 821.361-014 | Power Transformer Repairer<br>821.361.034 | Electric Motor Analyst<br>721.261-010 | Electric Motor Assembler and Tester<br>721.281-014 | Electric Motor Repairer<br>721.281-018 | Electrician<br>824.261-010 | Electrical Technician<br>003.161-010 |
|---|---|---|---|---|---|---|---|---|
| | DUTY A: Introduction to Electricity/ Electronics | | | | | | | |
| | | | | | | | | |
| IE-01 | Identifying sources of electrical energy | X | X | X | X | X | X | X |
| IE-02 | Identifying static electricity | X | X | X | X | X | X | X |
| IE-03 | Identifying principles of electric current | X | X | X | X | X | X | X |
| IE-04 | Identifying principles of electromagnetic induction | X | X | X | X | X | X | X |
| IE-05 | Identifying principles of current flow and resistance | X | X | X | X | X | X | X |
| IE-06 | Identifying resistors and capacitors | X | X | X | X | X | X | X |
| IE-07 | Identifying and using hand tools | X | X | X | X | X | X | X |
| IE-08 | Identifying conductors and fittings | X | X | X | X | X | X | X |
| IE-09 | Identifying DC circuits | X | X | X | X | X | X | X |
| IE-10 | Identifying AC circuits | X | X | X | X | X | X | X |
| | | | | | | | | |
| | DUTY B: Electrochemical Action and DC | | | | | | | |

## TASK LISTING BY DOT CODE

### ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| TASK NO. | TASK NAME | Electric Meter Installer<br>821.361-014 | Power Transformer Repairer<br>821.361.034 | Electric Motor Analyst<br>721.261-010 | Electric Motor Assembler and Tester<br>721.281-014 | Electric Motor Repairer<br>721.281-018 | Electrician<br>824.261-010 | Electrical Technician<br>003.161-010 |
|---|---|---|---|---|---|---|---|---|
| | DOT DESCRIPTIONS / DOT NO. | | | | | | | |
| EC-01 | Identifying basic principles of electrochemical action | | | X | | | X | X |
| EC-02 | Identifying types of batteries | | | X | | | X | X |
| EC-03 | Identifying the electrochemical action of batteries | | | X | | | X | X |
| EC-04 | Performing battery maintenance | | | X | | | X | X |
| EC-05 | Charging batteries and maintaining battery records | | | X | | | X | X |
| EC-06 | Identifying fundamental DC circuits | | | X | | | X | X |
| EC-07 | Identifying properties of DC circuits | | | X | | | X | X |
| EC-08 | Identifying properties of DC parallel circuits | | | X | | | X | X |
| EC-09 | Identifying series parallel circuits | | | X | | | X | X |
| EC-10 | Identifying practical application of DC circuits | | | X | | | X | X |
| | | | | | | | | |
| | DUTY C: Alternating Current | | | | | | | |
| | | | | | | | | |
| AC-01 | Identifying characteristics of AC circuits | X | X | X | | | X | X |

## TASK LISTING BY DOT CODE

ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| TASK NO. | TASK NAME | Electric Meter Installer | Power Transformer Repairer | Electric Motor Analyst | Electric Motor Assembler and Tester | Electric Motor Repairer | Electrician | Electrical Technician |
|---|---|---|---|---|---|---|---|---|
|  | DOT NO. | 821.361-014 | 821.361.034 | 721.261-010 | 721.281-014 | 721.281-018 | 824.261-010 | 003.161-010 |
| AC-02 | Identifying sine wave fundamentals | X | X | X |  |  | X | X |
| AC-03 | Calculating induction reactance | X | X | X |  |  | X | X |
| AC-04 | Calculating capacitive reactance | X | X | X |  |  | X | X |
| AC-05 | Identifying and calculating impedance | X | X | X |  |  | X | X |
| AC-06 | Identifying practical application of alternating current | X | X | X |  |  | X | X |
| AC-07 | Identifying polyphase circuits and calculating phase and line voltage |  | X | X |  |  | X | X |
| AC-08 | Identifying principles of transformers |  | X |  |  |  | X | X |
| AC-09 | Identifying transformer connections and installation |  | X |  |  |  | X | X |
| AC-10 | Maintaining transformers |  | X |  |  |  | X | X |
|  |  |  |  |  |  |  |  |  |
|  | DUTY D: Measuring Instruments |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| MI-01 | Identifying operating principles of electrical meters | X | X | X | X | X | X | X |
| MI-02 | Identifying and using DC instruments |  |  | X | X | X | X | X |

# TASK LISTING BY DOT CODE

## ELECTRICAL TECHNOLOGY

| | | POSSIBLE EXIT POINTS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DOT DESCRIPTIONS | Electric Meter Installer | Power Transformer Repairer | Electric Motor Analyst | Electric Motor Assembler and Tester | Electric Motor Repairer | Electrician | Electrical Technician |
| TASK NO. | TASK NAME / DOT NO. | 821.361-014 | 821.361.034 | 721.261-010 | 721.281-014 | 721.281-018 | 824.261-010 | 003.161-010 |
| MI-03 | Measuring resistance and insulating | X | X | X | X | X | X | X |
| MI-04 | Identifying operating principles of AC meters | X | X | X | X | X | X | X |
| MI-05 | Selecting a meter and making an AC measurement | X | X | X | X | X | X | X |
| MI-06 | Identifying and using power measuring instruments | X | X | X | X | X | X | X |
| MI-07 | Identifying and using special measuring instruments | X | X | X | X | X | X | X |
| MI-08 | Identifying and using indicating instruments | X | X | X | X | X | X | X |
| MI-09 | Identifying recording instruments and procedures for instrument care and maintenance | | | X | X | X | X | X |
| MI-10 | Identifying and using electronic measuring instruments | | | X | X | X | X | X |
| | | | | | | | | |
| | DUTY E: Protective Devices | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

# TASK LISTING BY DOT CODE

## ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| | DOT DESCRIPTIONS | Electric Meter Installer | Power Transformer Repairer | Electric Motor Analyst | Electric Motor Assembler and Tester | Electric Motor Repairer | Electrician | Electrical Technician |
|---|---|---|---|---|---|---|---|---|
| **TASK NO.** | **TASK NAME** / DOT NO. | 821.361-014 | 821.361.034 | 721.261-010 | 721.281-014 | 721.281-018 | 824.261-010 | 003.161-010 |
| PD-01 | Identifying and maintaining protective devices | X | X | X | X | X | X | X |
| PD-02 | Identifying and maintaining circuit breakers | | X | X | X | X | X | X |
| PD-03 | Identifying and maintaining overload relays | | X | X | X | X | X | X |
| PD-04 | Identifying applications of protective devices | | X | X | X | X | X | X |
| PD-05 | Grounding AC circuits | X | X | X | X | X | X | X |
| PD-06 | Identifying applications of the National Electrical Code | X | X | X | X | X | X | X |
| PD-07 | Making basic electrical calculations | X | X | X | | X | X | X |
| PD-08 | Identifying wireway systems | | X | X | | | X | X |
| PD-09 | Identifying methods of industrial illumination | | | | | | X | X |
| PD-10 | Identifying procedures for electrical safety and maintenance | X | X | X | X | X | X | X |
| | | | | | | | | |
| | DUTY F: DC Equipment and Controls | | | | | | | |
| | | | | | | | | |

## TASK LISTING BY DOT CODE

### ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| | DOT DESCRIPTIONS | Electric Meter Installer | Power Transformer Repairer | Electric Motor Analyst | Electric Motor Assembler and Tester | Electric Motor Repairer | Electrician | Electrical Technician |
|---|---|---|---|---|---|---|---|---|
| | DOT NO. | 821.361-014 | 821.361.034 | 721.261-010 | 721.281-014 | 721.281-018 | 824.261-010 | 003.161-010 |
| TASK NO. | TASK NAME | | | | | | | |
| DC-01 | Identifying sources of DC power for industry | | | X | | | | X |
| DC-02 | Identifying principles and applications of electromagnetism in DC circuits | | | X | | | | X |
| DC-03 | Identifying applications of DC generators | | | X | | | | X |
| DC-04 | Identifying principles and applications of DC motors | | | X | | | | X |
| DC-05 | Identifying types of and maintaining DC armatures | | | X | | | | X |
| DC-06 | Identifying types and operating principles of DC relays | | | X | | | | X |
| DC-07 | Identifying DC controllers and their operating principles | | | X | | | | X |
| DC-08 | Identifying and maintaining DC power supplies | | | X | | | | X |
| DC-09 | Identifying principles and applications of silicon controlled rectifiers | | | X | | | | X |
| | | | | | | | | |

## TASK LISTING BY DOT CODE

### ELECTRICAL TECHNOLOGY

| TASK NO. | TASK NAME | Electric Meter Installer | Power Transformer Repairer | Electric Motor Analyst | Electric Motor Assembler and Tester | Electric Motor Repairer | Electrician | Electrical Technician |
|---|---|---|---|---|---|---|---|---|
| | POSSIBLE EXIT POINTS — DOT NO. | 821.361-014 | 821.361.034 | 721.261-010 | 721.281-014 | 721.281-018 | 824.261-010 | 003.161-010 |
| DC-10 | Performing basic DC circuit maintenance | | | X | | | | X |
| | | | | | | | | |
| | DUTY G: Single-Phase Motors | | | | | | | |
| | | | | | | | | |
| SP-01 | Identifying basic operating principles of single-phase motors | | | X | X | X | | X |
| SP-02 | Identifying and maintaining split-phase motors | | | X | X | X | | X |
| SP-03 | Identifying and maintaining capacitor motors | | | X | X | X | | X |
| SP-04 | Identifying and maintaining repulsion motors | | | X | X | X | | X |
| SP-05 | Identifying and maintaining universal motors | | | X | X | X | | X |
| SP-06 | Identifying special purpose single-phase motors | | | X | X | X | | X |
| SP-07 | Identifying synchro-systems and applications | | | X | X | X | | X |
| | | | | | | | | |

## TASK LISTING BY DOT CODE

ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| TASK NO. | TASK NAME | Electric Meter Installer<br>821.361-014 | Power Transformer Repairer<br>821.361.034 | Electric Motor Analyst<br>721.261-010 | Electric Motor Assembler and Tester<br>721.281-014 | Electric Motor Repairer<br>721.281-018 | Electrician<br>824.261-010 | Electrical Technician<br>003.161-010 |
|---|---|---|---|---|---|---|---|---|
| | DOT DESCRIPTIONS / DOT NO. | | | | | | | |
| SP-08 | Identifying servomechanisms and their principles of operation | | | X | X | X | | X |
| SP-09 | Identifying starting and protection devices for single-phase motor | | | X | X | X | | X |
| SP-10 | Performing single-phase motor maintenance and repairs | | | X | X | X | | X |
| | | | | | | | | |
| | DUTY H: Polyphase Systems | | | | | | | |
| | | | | | | | | |
| PS-01 | Identifying basic principles of polyphase motors | | | X | X | X | | X |
| PS-02 | Identifying induction motors and their operating principles and maintaining them | | | X | X | X | | X |
| PS-03 | Identifying and maintaining synchronous motor | | | X | X | X | | X |
| PS-04 | Identifying, hooking up and operating multi-speed dual voltage | | | X | X | X | | X |
| PS-05 | Maintaining polyphase motors | | | X | X | X | | X |
| | | | | | | | | |

## TASK LISTING BY DOT CODE

### ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| | DOT DESCRIPTIONS | Electric Meter Installer | Power Transformer Repairer | Electric Motor Analyst | Electric Motor Assembler and Tester | Electric Motor Repairer | Electrician | Electrical Technician |
|---|---|---|---|---|---|---|---|---|
| | DOT NO. | 821.361-014 | 821.361.034 | 721.261-010 | 721.281-014 | 721.281-018 | 824.261-010 | 003.161-010 |
| TASK NO. | TASK NAME | | | | | | | |
| PS-06 | Identifying basic principles of AC motor starting | | | X | X | X | | X |
| PS-07 | Identifying polyphase motor controllers and their operating principles | | | X | X | X | | X |
| PS-08 | Identifying alternators and their operating principles | | | X | X | X | | X |
| PS-09 | Identifying and maintaining auxiliary generator systems | | | X | X | X | | X |
| PS-10 | Identifying and maintaining power distribution systems | | | X | X | X | | X |
| | DUTY I: AC Control Equipment | | | | | | | |
| ACC-01 | Identifying AC motor starter circuit components | | | X | | X | | X |
| ACC-02 | Identifying and operating pushbutton control stations | | | X | | X | | X |
| ACC-03 | Identifying limit switches and their applications | | | X | | X | | X |

## TASK LISTING BY DOT CODE

ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| TASK NO. | TASK NAME | DOT DESCRIPTIONS: Electric Meter Installer<br>DOT NO.: 821.361-014 | Power Transformer Repairer<br>821.361.034 | Electric Motor Analyst<br>721.261-010 | Electric Motor Assembler and Tester<br>721.281-014 | Electric Motor Repairer<br>721.281-018 | Electrician<br>824.261-010 | Electrical Technician<br>003.161-010 |
|---|---|---|---|---|---|---|---|---|
| ACC-04 | Identifying special control switches and their applications | | | X | | X | | X |
| ACC-05 | Identifying types of timers and counters and their applications | | | X | | X | | X |
| ACC-06 | Identifying and maintaining control relays | | | X | | X | | X |
| ACC-07 | Identifying and maintaining types of industrial AC controls used in hazardous locations | | | X | | X | | X |
| ACC-08 | Identifying special motor control circuits and related schematics | | | X | | X | | X |
| ACC-09 | Identifying and installing motor control centers | | | X | | X | | X |
| ACC-10 | Wiring a control panel | | | X | | X | | X |
| | | | | | | | | |
| | DUTY J: Electrical Troubleshooting | | | | | | | |
| | | | | | | | | |
| ET-01 | Troubleshooting with electrical schematics | | | X | | X | | X |
| | | | | | | | | |

## TASK LISTING BY DOT CODE

### ELECTRICAL TECHNOLOGY

POSSIBLE EXIT POINTS

| TASK NO. | TASK NAME | DOT NO. 821.361-014<br>DOT DESCRIPTIONS Electric Meter Installer | 821.361-034<br>Power Transformer Repairer | 721.261-010<br>Electric Motor Analyst | 721.281-014<br>Electric Motor Assembler and Tester | 721.281-018<br>Electric Motor Repairer | 824.261-010<br>Electrician | 003.161-010<br>Electrical Technician |
|---|---|---|---|---|---|---|---|---|
| ET-02 | Troubleshooting electrical circuits using building drawings | | | X | | | | X |
| ET-03 | Troubleshooting control circuits | | X | | | X | | X |
| ET-04 | Troubleshooting combination starters | | X | | | X | | X |
| ET-05 | Troubleshooting control devices | | X | | | X | | X |
| ET-06 | Troubleshooting special controls | | X | | | | | X |
| ET-07 | Troubleshooting DC motors | | X | | | X | | X |
| ET-08 | Troubleshooting AC motors | | X | | | X | | X |
| ET-09 | Troubleshooting lighting systems | | | | | | | X |

# SECTION III

## UNIT GUIDES

# SECTION III

## Section III Content List

Unit Guide Description
Suggested Sequence of Unit Guides

In Section II, the relationship between the occupational area and program tasks was introduced. Section III continues this development by presenting, for each task, a unit guide for instructional planning and execution.

The instruction of specific tasks is central to vocational education. However, the value of a single task/competency to the student as a prospective member of the workforce is dependent upon the way in which that task/competency is related to other tasks and to the entire occupational area. Therefore, the Electrical Technology Program Task Listing provides a sample organizational model for sequencing the instruction of program tasks.

## UNIT GUIDES DESCRIPTION

In this section the tasks to be taught in each course are presented in sequential order. Each task is listed on a separate page so that it may be taken out of the guide for daily lesson planning or regrouped with order tasks to fit the individual teacher's preference for teaching order. The task pages may be used for planning and executing group instruction or for individualized instruction. Each page in the UNIT GUIDES section contains the following information:

TASK: This is a short and concise statement of the task to be taught.

PERFORMANCE OBJECTIVE: The performance expected of the student after completing the unit is stated in stem form, without a specific statement of all conditions, equipment and performance standard (these are listed in a criterion referenced measure in the Evaluation section of the task page).

INSTRUCTIONAL ACTIVITIES: Suggested learning activities are presented. These activities include providing information, demonstration, practical applications and projects.

INSTRUCTIONAL MATERIALS: Suggested materials for carrying out the instructional activities are listed. these include textbooks, audiovisuals and equipment. Textbooks are referenced by author and title with the complete reference contained in the textbook list in the Instructional Resources section.

EVALUATION: This section contains a criterion referenced measure and reference to any test items or other evaluation measures that are available to teacher.

CLASS/LAB HOURS: The estimated time for completion of the instructional activities and the evaluation are indicated in both classroom and lab hours. Total instructional time would be the sum of these.

# ELECTRICAL TECHNOLOGY TASK LISTING

Page No.

## DUTY I: Introduction to Electricity/Electronics

IE-01 Identifying sources of electrical energy..........11
IE-02 Identifying static electricity..........13
IE-03 Identifying principles of electric current and voltage..........15
IE-04 Identifying principles of electromagnetic induction..........17
IE-05 Identifying principles of current flow and resistance..........19
IE-06 Identifying resistors and capacitors..........21
IE-07 Identifying and using hand tools..........23
IE-08 Identifying conductors and fittings..........25
IE-09 Identifying DC circuits..........27
IE-10 Identifying AC circuits..........29

## DUTY II: Electrochemical Action and DC

EC-01 Identifying basic principles of electrochemical action..........31
EC-02 Identifying types of batteries..........33
EC-03 Identifying the electrochemical action of batteries..........35
EC-04 Performing battery maintenance..........37
EC-05 Charging batteries and maintaining battery records..........39
EC-06 Identifying fundamental DC circuits..........41
EC-07 Identifying properties of DC series circuits..........43
EC-08 Identifying properties of DC parallel circuits..........45
EC-09 Identifying series - parallel circuits..........47
EC-10 Identifying practical application of DC circuits..........49

## DUTY III: Alternating Current

AC-01 Identifying characteristics of AC circuits..........51
AC-02 Identifying sine wave fundamentals..........53
AC-03 Calculating inductive reactance..........55
AC-04 Calculating capacitive reactance..........57
AC-05 Identifying and calculating impedance..........59
AC-06 Identifying practical applications of alternating current..........61
AC-07 Identifying polyphase circuits and calculating phase and line voltage..........63
AC-08 Identifying principles of transformers..........65
AC-09 Identifying transformer connections, applications and installations..........67
AC-10 Maintaining transformers..........69

Page No.

## DUTY IV: Measuring Instruments

MI-01 Identifying operating principles of electric meters .......... 71
MI-02 Identifying and using DC instruments .......... 73
MI-03 Measuring resistance and insulation .......... 75
MI-04 Identifying operating principles of AC meters .......... 77
MI-05 Selecting a meter and making an AC measurement .......... 79
MI-06 Identifying and using power measuring instruments .......... 81
MI-07 Identifying and using special measuring instruments .......... 83
MI-08 Identifying and using indicating instruments .......... 85
MI-09 Identifying recording instruments and procedures for instrument care and maintenance .......... 87
MI-10 Identifying and using electronic measuring instruments .......... 89

## DUTY V: Protective Devices

PD-01 Identifying and maintaining protective devices .......... 91
PD-02 Identifying and maintaining circuit breakers .......... 93
PD-03 Identifying and maintaining overload relays .......... 95
PD-04 Identifying applications of protective devices .......... 97
PD-05 Grounding AC circuits .......... 99
PD-06 Identifying applications of the National Electrical Code .......... 101
PD-07 Making basic electrical calculations .......... 103
PD-08 Identifying wireway systems .......... 105
PD-09 Identifying methods of industrial illumination .......... 107
PD-10 Identifying procedures for electrical safety and maintenance .......... 109

## DUTY VI: DC Equipment and Controls

DC-01 Identifying sources of DC power in industry .......... 111
DC-02 Identifying principles and applications of electromagnetism in DC circuits .......... 113
DC-03 Identifying applications of DC generators .......... 115
DC-04 Identifying principles and applications of DC motors .......... 117
DC-05 Identifying types of DC armatures and maintaining them .......... 119

Page No.

DC-06 Identifying types and operating principles of DC relays ..... 121
DC-07 Identifying DC controllers and their operating principles ..... 123
DC-08 Identifying and maintaining DC power supplies ..... 125
DC-09 Identifying principles and applications of silicon controlled rectifiers (SCR) ..... 127
DC-10 Performing basic DC circuit maintenance ..... 129

DUTY VII: Single-Phase Motors

SP-01 Identifying basic operating principles of single-phase motors ..... 131
SP-02 Identifying and maintaining split-phase motors ..... 133
SP-03 Identifying and maintaining capacitor motors ..... 135
SP-04 Identifying and maintaining repulsion motors ..... 137
SP-05 Identifying and maintaining universal motors ..... 139
SP-06 Identifying special purpose single-phase motors ..... 141
SP-07 Identifying synchro systems and applications ..... 143
SP-08 Identifying servomechanisms and their principles of operation ..... 145
SP-09 Identifying starting and protection devices for single-phase motors ..... 147
SP-10 Performing single-phase motor maintenance and repair ..... 149

DUTY VIII: Polyphase Systems

PS-01 Identifying basic principles of polyphase motors ..... 151
PS-02 Identifying induction motors, their operating principles and maintaining them ..... 153
PS-03 Identifying and maintaining synchronous motors ..... 155
PS-04 Identifying, hooking up and operating multi-speed dual voltage motors ..... 157
PS-05 Maintaining polyphase motors ..... 159
PS-06 Identifying basic principles of AC motor starting ..... 161
PS-07 Identifying polyphase motor controllers and their principles of operation ..... 163
PS-08 Identifying alternators and their applications ..... 165
PS-09 Identifying and maintaining auxiliary generator systems ..... 167

Page
No.

PS-10 Identifying and maintaining power distribution systems....................................169

DUTY IX: AC Control Equipment

ACC-01 Identifying AC motor starter circuit and components....................................171
ACC-02 Identifying and operating pushbutton control stations....................................173
ACC-03 Identifying limit switches and their applications....................................175
ACC-04 Identifying special control switches and their applications....................................177
ACC-05 Identifying types of timers and counters and their applications....................................179
ACC-06 Identifying and maintaining control relays.........181
ACC-07 Identifying and maintaining types of industrial AC controls used in hazardous locations....................................183
ACC-08 Identifying special motor control circuit and related schematics....................................185
ACC-09 Identifying and installing motor control centers....................................187
ACC-10 Wiring a control panel....................................189

DUTY X: Electrical Troubleshooting

ET-01 Troubleshooting with electrical schematics.........191
ET-02 Troubleshooting electrical circuits using building drawings....................................193
ET-03 Troubleshooting control circuits..................195
ET-04 Troubleshooting combination starters...............197
ET-05 Troubleshooting control devices..................199
ET-06 Troubleshooting special controls..................201
ET-07 Troubleshooting DC motors.........................203
ET-08 Troubleshooting AC motors.........................205
ET-09 Troubleshooting lighting systems..................207

## TASK

IE-01 Identifying sources of electrical energy

## PERFORMANCE OBJECTIVE

Identifying sources of electrical energy.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Electricity
    1. Electrons
    2. Electron theory
    3. Amber
b. Molecules
    1. Electric current
    2. Matter
    3. Elements
    4. Compounds
    5. Mixtures
c. Structure of the atom
    1. Protons
    2. Neutrons
    3. Nucleus
    4. Periodic table of the elements
    5. Atomic weight

(Continued on back)

Provide Demonstration On:

a. Static electricity
b. The structure of an atom
c. Resistance using a water pipe as an example

Provide Practical Application On:

Drawing an atom and labling the parts

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. AAVIM, Understanding Electricity and Electrical Terms

A/Vs:

a. Bergwall, "Basic Electricity and Electronics Explained," filmstrip
b. AAVIM, "Electrical Energy," slide/tape

Student Manuals:

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson One

Tools and Equipment:

a. Static electricity demonstration kit
b. Chart of a simple atom
c. Water pipes

| | |
|---|---|
| **LAB HOURS** | 1 |
| **CLASS HOURS** | 5 |

## EVALUATION (IE-01)

Given a list of basic electrical concepts and terms relating to sources of electrical energy, the student will correctly identify the terms and/or describe the concepts to a minimum of 85% accuracy.

Provide Information On:

d. Static electricity
e. Electron flow
f. Electrical current
    1. Voltage
    2. Electroscope
    3. Electric circuit
g. Measuring current
    1. Coulomb
    2. Ampere
h. Resistance (ohm)
i. Electrical pressure
    1. Voltage
    2. Electromotive force
    3. Potential difference
j. Electrical effects
    1. Heat
    2. Magnetism
    3. Shock

## TASK

IE-02 Identifying static electricity

## PERFORMANCE OBJECTIVE

Identify properties of static electricity.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The production of static electricity
  1. Electrostatic force or charge
  2. Contact or induction
b. Discharge of static charges
c. Natural static charges
d. Problems caused by static electricity
e. Static hazards
f. Uses and controls of static electricity
g. Grounding
h. Static neutralizers
  1. High voltage neutralizers
  2. Induction neutralizers

Provide Demonstration On:

a. How static electricity is produced and discharged
b. Using pith balls and electroscope

Provide Practical Application On:

Several examples of how static charges are used in precipitators and neutralizers

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. AAVIM, Understanding Electricity and Electrical Terms
c. Howard W. Sams, ABC's of Electricity

A/Vs:

a. Bergwall, "Basic Electricity and Electronics Explained," filmstrip
b. AAVIM, "Electrical Energy," slide/tape

Student Manuals:

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson Two

Tools and Equipment:

a. Pith ball electroscope and two pith balls
b. Rubber rod
c. Wool cloth
d. Sponge and water

| | |
|---|---|
| **LAB HOURS** | 1 |
| **CLASS HOURS** | 5 |

## EVALUATION (IE-02)

Given a test with terms and concepts relating to static electricity, the student will identify the terms and describe their applications with 85% accuracy.

## TASK

IE-03 Identifying principles of electric current and voltage

## PERFORMANCE OBJECTIVE

Identifying principles of electric current and voltage.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Methods of producing current flow
  - 1. Dry cells
  - 2. Generators
  - 3. An electric circuit
- b. Methods of producing voltage
  - 1. Friction
  - 2. Pressure (pie 30 electricity)
  - 3. Heat (thermoelectricity)
  - 4. Light (photoelectricity)
  - 5. Chemical action
- c. Primary cells
- d. Secondary cells
- e. Voltage produced by magnetism

Provide Demonstration On:

- a. Production of electric voltage by batteries
- b. Production of electric voltage by generator

## INSTRUCTIONAL MATERIALS

Textbooks:

- a. Training and Retraining, Inc., Basic Electricity/Electronics
- b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson Three

Tools and Equipment:

- a. Batteries
- b. Small generator
- c. Wires
- d. Voltmeter

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (IE-03)

Given the following terms relating to methods of producing voltage, the student will define the terms and accurately describe at least five of the following processes

1. Friction
2. Pressure
3. Heat
4. Light
5. Chemical action
6. Magnetism

## TASK

IE-04 Identifying principles of electromagnetic induction

## PERFORMANCE OBJECTIVE

Identify principles of electromagnetic induction.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. History of magnetism
b. Types of magnets
    1. Natural magnets
    2. Permanent magnets
    3. Electromagnets
c. Molecular theory of magnetism
d. Magnetomotive force
e. Reluctance of a magnetic circuit
f. Magnetism from electricity
g. Voltage produced by magnetism
    1. Conductor
    2. Magnetic field
    3. Relative motion between field and conductor

(Continued on back)

Provide Demonstration On:

a. Operation of an electromagnet
b. Production of electricity by a simple generator
c. Field trip to a power plant

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson Four

Tools and Equipment:

a. Electromagnet
b. Simple generator
c. Simple voltmeter

**LAB HOURS** 5

**CLASS HOURS** 5

## EVALUATION (IE-04)

Given a basic, simple generator, the student will describe how the generator produces voltage and identify the conductor, the magnetic field and the motion required between the field and conductor to produce the electricity.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Electromagnetism
i. Electromagnetism induction

## TASK

IE-05 Identifying principles of current flow and resistance

## PERFORMANCE OBJECTIVE

Identify principles of current flow and resistance.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Current flow
b. Current measurement
c. Voltage
d. Potential difference
e. Operating voltages
f. Dangerous voltages and safety
g. Voltmeters
h. Resistance
i. Ohm's law
j. Measuring resistance

Provide Demonstration On:

a. Measuring voltage with a voltmeter
b. Measuring resistance with an ohmmeter

Provide Practical Application On:

a. Using a voltmeter to measure voltage
b. Using an ohmmeter to measure resistance

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson Five

Tools and Equipment:

a. Ohmmeter
b. Voltmeter
c. Circuit to test

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (IE-05)

Given an electric circuit, a voltmeter and an ohmmeter, the student will accurately measure the voltage and resistance of the circuit and accurately define voltage and resistance.

## TASK

IE-06 Identifying resistors and capacitors

## PERFORMANCE OBJECTIVE

Identify types of resistors and capacitors.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Definition of a resistor
b. Types of resistors
    1. Carbon
    2. Wirewound
    3. Variable (rheostats and potentiometers)
c. Resistance measurements
    1. Ohm
    2. Ohmmeter
    3. Ohmmeter setup
d. Resistor color codes
e. Resistor ratings
f. Power and power formula
    1. Rate
    2. Instantaneous power rate
    3. Watt

(Continued on back)

**Provide Demonstration On:**

a. Identifying resistor valves by color code
b. Identifying capacitor ratings

**Provide Practical Application On:**

a. Identifying resistor valves from a group of resistors
b. Identifying capacitor ratings from a group of capacitors

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

**A/Vs:**

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

**Student Manuals:**

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson Six

**Tools and Equipment:**

a. Several types and sizes of resistors
b. Several types and sizes of capacitors

LAB HOURS 5
CLASS HOURS 10

## EVALUATION (IE-06)

Given a selection of resistors and capacitors of various ratings, the student will identify the rating of each capacitor and resistor with 100% accuracy.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Capacitance
h. Rating of capacitors or condensers
i. Capacitor symbols
j. Dielectric materials
k. Insulation resistance

## TASK

IE-07 Identifying and using hand tools

## PERFORMANCE OBJECTIVE

Identify and use hand tools.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Screwdrivers
    1. Types
    2. Uses
    3. Safety
b. Hammers
    1. Carpenter's hammer
    2. Machinist's hammer
    3. Soft face hammer
c. Wrenches
    1. Type
    2. Uses
    3. Safety
d. Pliers
    1. Types
    2. Uses
    3. Safety
e. Non-sparking tools

(Continued on back)

Provide Demonstration On:

a. Bending conduit
b. Splicing wires
c. Soldering

Provide Practical Application On:

a. Bending conduit to a specified angle
b. Splicing wires using an all-purpose tool

## INSTRUCTIONAL MATERIALS

Textbooks:

Dover, Tools and Their Uses

Student Manuals:

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson Seven

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Hammers
d. Pliers
e. Conduit benders
f. Hacksaws
g. Splicing tools
h. Drills
i. Soldering gun and supplies

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 5 |

## EVALUATION (IE-07)

Given the following tools, the student will demonstrate the correct and safe use of the tools by performing tasks assigned by their instructor.

1. Screwdriver
2. Wrench
3. Hammer
4. Pliers
5. Conduit bender
6. Hacksaw
7. Splicing tools
8. Drill
9. Soldering gun

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Conduit benders
    1. Rigid type conduit
    2. EMT type conduit
    3. Pipe benders
    4. Hickey
g. Splicing tools
    1. Types
    2. All-purpose tools
    3. Soldering iron
h. Hacksaws
i. Metal cutting tools
    1. Drill
    2. Hole saw
    3. Knockout punch

## TASK

IE-08 Identifying conductors and fittings

## PERFORMANCE OBJECTIVE

Identify conductors and fittings.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Properties of conductor materials
    1. Conductors
    2. Insulators
    3. Semiconductors
    4. Dielectrics
b. Conductors
    1. National Electrical Code
    2. Current
    3. Voltage drop
c. Wire sizes
    1. Mils or circular mils
    2. Square mils
    3. Mil-foot
    4. Specific resistivity
    5. American Wire Gage (AWG)
    6. Wire gages

(Continued on back)

Provide Demonstration On:

Using a wire gage

Provide Practical Application On:

Using a wire gage to determine wire size

## INSTRUCTIONAL MATERIALS

Textbooks:

a. NEC Handbook
b. Training and Retraining Inc., Basic Electricity/Electronics
c. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson Eight

Tools and Equipment:

a. Wires
b. Wire gage

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 5 |

## **EVALUATION** (IE-08)

Given a conductor and related couplings or fittings, the student will identify the type and size of conductor and correctly describe its applications as they relate to NEC standards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Conductor classification
    1. Bare
    2. Covered
    3. Insulated
    4. Stranded
    5. Cable
e. Conductor insulation
f. Conductor protection
    1. Covered
    2. Weatherproof
    3. Insulated
g. Insulating tapes
    1. Friction
    2. Rubber
    3. Plastic
    4. Varnished
h. Mechanical protection
    1. Raceway
    2. Rigid metal conduit
    3. Electrical metal tubing, couplings and connectors
i. Flexible conduit

## TASK

IE-09 Identifying DC circuits

## PERFORMANCE OBJECTIVE

Identify DC circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC current
b. Voltage
c. Current flow
d. Resistance
e. Power formula
f. Ohm's law
g. Simple DC circuits
h. Series DC circuits
i. Parallel DC circuits
    1. Open circuit
    2. Short circuit

Provide Demonstration On:

Working electrical problems

Provide Practical Application On:

Working on electrical problem
1. Diagramming the circuit
2. Labeling the parts
3. Assigning known valves
4. Tracing direction of current flow
5. Figuring unknowns using appropriate formulas

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., *Basic Electricity/Electronics*
b. Loper, *Introduction to Electricity and Electronics*

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, *Introduction to Electricity and Electronics, Lesson Nine*

Tools and Equipment:

a. DC circuits, parallel and series
b. Paper and pencil

LAB HOURS 5
CLASS HOURS 5

## EVALUATION (IE-09)

a. Given a DC circuit, either series or parallel, the student will accurately identify, diagram, label and trace the current flow.

b. Using the formula for Ohm's law, the student will figure unknown circuit quantities.

## TASK

IE-10 Identifying AC circuits

## PERFORMANCE OBJECTIVE

Identify basic principles of AC circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. AC and DC compared
b. Advantages of AC current
c. Production of AC current
    1. Generator
    2. Electromagnetic
    3. Cycle
    4. Cycles-per-second (hertz)
d. Electrical time signs
e. Producing an AC voltage
f. Resistance in AC circuits
g. Inductance in AC circuits
    1. Lenz's law
    2. Determining inductance
    3. Henry
h. Inductive reactance
i. Capacitance in AC circuits

(Continued on back)

Provide Demonstration On:

Figuring the following in an AC circuit
1. Resistance
2. Inductance
3. Capacitance
4. Power factor
5. Impedance

Provide Practical Application On:

Figuring an AC circuit
1. Resistance
2. Inductance
3. Capacitance
4. Power factor
5. Impedance

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Introduction to Electricity and Electronics, Lesson Ten

Tools and Equipment:

a. AC circuits
b. Paper and pencil

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (IE-10)

Given an AC circuit and basic valves, the student will accurately calculate the following information

1. Resistance
2. Inductance
3. Capacitance
4. Power factor
5. Impedance

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Current flow in AC circuits
    1. In-phase
    2. Current lags voltage
    3. Current leads voltage
    4. Phase difference
    5. Phase angle
    6. Impedance

k. Power factor

l. Effective valves in AC
    1. Average valve
    2. Effective valve

## TASK

EC-01 Identifying basic principles of electrochemical action

## PERFORMANCE OBJECTIVE

Identify basic principles of electrochemical action.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. History of batteries
b. Battery characteristics
    1. Electrochemical action
    2. Cello-primary and secondary
    3. Ampere-hour capacity
    4. Temperature effects
    5. Maintenance producers
c. Electrochemical action
    1. Electrode
    2. Electrolyte
d. Battery chemistry
    1. Positive electrode - copper (Cu)
    2. Negative electrode - zinc (Zn)

(Continued on back)

Provide Demonstration On:

How a battery works

Provide Practical Application On:

Selecting a battery for a given application

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson One

Tools and Equipment:

Battery demonstration (clear case type)

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 1 |

## EVALUATION (EC-01)

Given a specified application, the student will select a specific type battery appropriate to that application and accurately describe the electrochemical action of the battery in terms of the electrodes and the electrolyte.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

   3. Electrolyte - solution of sulfuric acid and water - $CH_2SO_4$
   4. Zinc sulfate ($Z_NSO_4$)
   5. Polarization and depolarization

e. Electrolysis
f. Electroplating
   1. Cathode
   2. Anode

g. Refinishing initials
h. Extracting initials
i. Electrolytic corrosion
j. Electrolyte
k. Temperature
l. Impurities
m. Specific gravity
n. Battery power
o. Battery selection

## TASK

EC-02 Identifying types of batteries

## PERFORMANCE OBJECTIVE

Identify types of batteries, their characteristics and ratings.

## INSTRUCTIONAL ACTIVITIES

**Provide Information On:**

a. Battery cells
    1. Primary cell
    2. Secondary cell
    3. Leclanche cell
    4. Dry cells
b. Dry cell construction
c. Dry cell characteristics
    1. Voltage
    2. Connected in series voltage
    3. Capacity
    4. Best operating temperature
d. New types of primary cells
    1. Mercury oxide
    2. Types stored without electrolyte

(Continued on back)

**Provide Demonstration On:**

Hooking up dry cells in series to produce a desired voltage

**Provide Practical Application On:**

Hooking up dry cells in series to produce a desired voltage

## INSTRUCTIONAL MATERIALS

**Textbooks:**

a. Training and Retraining, Inc., *Basic Electricity/Electronics*
b. Loper, *Introduction to Electricity and Electronics*

**Student Manuals:**

Plant Engineering Training Systems, *Electrochemical Action and DC, Lesson Two*

**Tools and Equipment:**

a. Dry cell batteries
b. Wires
c. DC voltmeter

**LAB HOURS** 5

**CLASS HOURS** 1

## **EVALUATION** (EC-02)

Given a specified application, the student will select a battery (or batteries) for that application, describe its type and characteristics and hook up the batteries in series to produce a desired voltage.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Secondary cells
    1. Storage cells
    2. Recharging
f. Stationary batteries
g. Storage cell construction
    1. Plates
    2. Separators
    3. Vent plugs
    4. Cell connectors
h. Storage battery ratings
    1. Ampere hours
    2. Watt hours
    3. Voltage rating
    4. Internal resistance - voltage drop
i. Battery life

## TASK

EC-03 Identifying the electrochemical action of batteries

## PERFORMANCE OBJECTIVE

Identify the electrochemical action of batteries.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Lead acid batteries
   1. Lead-plates
   2. Electrolyte - sulfuric acid and water solution
   3. Chemical action
   4. Construction

b. Lead-calcium batteries
   1. Construction
   2. Advantages
   3. Voltage

c. Specific gravity

d. Capacity
   1. Discharge rate
   2. Temperature
   3. Specific gravity
   4. Final voltage

(Continued on back)

Provide Practical Application On:

Identifying several types of batteries with respect to
1. Type
2. Applications
3. Electrochemical action
4. Capacity
5. Characteristics

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics

b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson Three

Tools and Equipment:

Several types of batteries

| | |
|---|---|
| **LAB HOURS** | 5 |
| **CLASS HOURS** | 5 |

## **EVALUATION** (EC-03)

Given several types of batteries, the student will identify each battery to

1. Type
2. Application
3. Electro-chemical action
4. Capacity
4. Characteristics

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Nickel-iron-alkaline batteries
    1. Industrial applications
    2. Electro-chemical action
    3. Construction
    4. Capacity
    5. Characteristics

f. Nickel-cadmium-alkaline batteries (NICAD)
    1. Applications
    2. Chemical action
    3. Construction
    4. Voltage
    5. Capacity

## TASK

EC-04 Performing battery maintenance

## PERFORMANCE OBJECTIVE

Perform battery maintenance.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. New battery inspection
   1. Wet spots
   2. Electrolyte level
   3. Distilled water
b. Placing a battery in service
   1. Charging
   2. Specific gravity of electrolyte
   3. Safety
c. Care of dry charged batteries
d. Placing a dry charged battery in service
   1. Produce
   2. Storage requirements

(Continued on back)

Provide Demonstration On:

a. Using a hydrometer
b. Installing a new battery into service

Provide Practical Application On:

Inspecting a new battery and installing it in a given application

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson Four

Tools and Equipment:

a. Hydrometer
b. Batteries
c. Distilled water
d. Tools

LAB HOURS 5

CLASS HOURS 5

**EVALUATION** (EC-04)

Given an assigned application and a new battery and by following correct procedures, the student will follow correctly, inspect and set up the battery.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Care of set charged batteries
    1. Self-discharge
    2. Storage requirements
f. Charging procedures
    1. Manually cycled
    2. System governed
    3. Floated
g. Specific gravity
    1. Battery hydrometer
    2. Normal readings
h. Battery testing
i. How temperature affects batteries
j. Industrial truck battery use
k. Battery troubles and care

## TASK

EC-05 Charging batteries and maintaining battery records

## PERFORMANCE OBJECTIVE

Charge batteries and maintain battery records.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Principles of battery charging
    1. Undercharging
    2. Overcharging
    3. Correct charge
b. Types of charges
    1. Initial charge
    2. Normal charge
    3. Equalizing charge
    4. Trickle charge
    5. Emergency charge
    6. Constant potential
    7. Modified constant voltage
    8. Boost charge
    9. Freshening charge

(Continued on back)

Provide Demonstration On:

a. Mixing electrolyte
b. Testing battery charge
c. Charging a battery

Provide Practical Application On:

Testing a battery for proper charge, mixing additional electrolyte and charging the battery

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson Five

Tools and Equipment:

a. Electrolyte
b. Battery
c. Safety goggles
d. Rubber apron
e. Boots
f. Gloves

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (EC-05)

Given a battery, the student will follow correct and safe procedures for checking battery charge, mixing additional electrolyte and charging the battery.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

c. Battery test discharge
    1. Recording time
    2. Individual cell voltages
    3. Battery voltage
    4. Local action
    5. Cell short-circuits
    6. Loss of electrolyte
    7. Reversed cell
d. Mixing electrolyte
    1. Safety items
    2. Safety in handling
e. Battery charging tests
    1. Records
    2. Comparing specific gravity
    3. Testing discharge
f. Battery charging sources
g. Battery charging safety
h. Battery records
i. Cells in series and parallel

## TASK

EC-06 Identifying fundamental DC circuits

## PERFORMANCE OBJECTIVE

Identify fundamental DC circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Sources of DC
b. Ohm's law
c. Power formula
d. Work
    1. Definition
    2. Formula
    3. Foot-pound
e. Torque
f. Power
g. Power and resistance
h. Simple machines
i. Mechanical advantage and efficiency
j. Kirchoff's laws
k. Graphs

Provide Demonstration On:

Working example problems
1. Ohm's law
2. Power formula
3. Work
4. Torque

Provide Practical Application On:

a. Working problems on
    1. Ohm's law
    2. Power formula
    3. Work
    4. Torque
b. Drawing graphs showing relationship of answers to volts and watts to current in a DC circuit

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson Six

Tools and Equipment:

a. Graph paper
b. Pencils

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 2 |

## EVALUATION (EC-06)

Given specifications for a DC circuit, the student will identify the type of circuit and solve a given set of problems using

1. Ohm's law
2. Power formula
3. Torque
4. Graph amperes
5. Volts

Answers should be 100% correct.

## TASK

EC-07 Identifying properties of DC series circuits

## PERFORMANCE OBJECTIVE

Identify properties of DC series circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Characteristics of a circuit in series
b. Current control
   1. Resistors
   2. Field windings
   3. Rheostats
c. Voltage drop
d. Applying Kirchoff's law
e. Power relationships

Provide Demonstration On:

Working series DC circuit
1. Voltage drop problems
2. Resistance valve problems

Provide Practical Application On:

Working DC series circuits
1. Voltage drop problems
2. Resistance valve problems

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training System, Electrochemical Action and DC, Lesson Seven

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 1 |

## EVALUATION (EC-07)

a. Given a DC circuit series with a known total voltage and total resistance and three resistors (two with given values), the student will compute the value of the unknown resistor.

b. The student will compute the voltage drop experienced in a given DC circuit which is wired in series, when a component of known resistance value is added to the circuit.

## TASK

EC-08 Identifying properties of DC parallel circuits

## PERFORMANCE OBJECTIVE

Identify properties of DC parallel circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Parallel vs. series circuit
b. Identifying a parallel circuit
c. Voltage drop in parallel circuits
d. Current flow in parallel circuits
e. Resistance in parallel circuits
f. Determining resistance in parallel circuits
g. Resistance, conductance and reciprocals
h. Applying Ohm's law and Kirchoff's laws to power valves

Provide Demonstration On:

Determining resistance in a parallel circuit

Provide Practical Application On:

Determining resistance in a parallel circuit

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson Eight

Tools and Equipment:

a. Series circuit
b. Parallel circuit

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 2 |

## EVALUATION (EC-08)

Given a series and parallel circuit, the student will correctly identify the parallel circuit and determine all unknown resistance values with 100% accuracy.

## TASK

EC-09 Identifying series - parallel circuits

## PERFORMANCE OBJECTIVE

Identify series-parallel circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Complex circuits
b. Series-parallel circuit applications
c. Kirchoff's law
d. Series-parallel circuit resistances
    1. Total resistance
    2. Total effective resistance
e. Method for two resistors in parallel
f. Redrawing and simplifying plant wiring circuits
g. Tracing current flow
h. Series-parallel resistance applications
i. Calculating circuit valves
    1. Current (amperes)
    2. Resistance (ohms)
    3. Power (watts)

Provide Demonstration On:

a. Figuring total effective resistance in a circuit with two resistors in parallel
b. Figuring current, resistance and power for a given parallel circuit

Provide Practical Application On:

Figuring for a series-parallel circuit
1. Total effective resistance for two resistors in parallel
2. Current
3. Resistance
4. Power

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson Ten

Tools and Equipment:

Circuit with two resistors in parallel

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 3 |

## EVALUATION (EC-09)

Given a series-parallel circuit with two resistors in parallel, the student will accurately calculate

1. Total effective resistance for the resistor
2. Power
3. Current
4. Circuit resistance

## TASK

EC-10 Identifying practical applications of DC circuits

## PERFORMANCE OBJECTIVE

Identify practical applications of DC circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Total voltage
b. Terminal voltage
c. Series-parallel circuits applied to DC motors
d. Shunt motor circuit
e. Voltage dividers
f. Basic lighting circuit
g. Three-way switch circuits
h. Four-way switch circuits
i. Efficiency
j. Energy
k. Electrical and mechanical power conversion
l. Torque
  1. Formula wheel
  2. Ohm's law
  3. Power formula

Provide Demonstration On:

a. Figuring efficiency of a DC motor
b. Figuring the torque produced by a DC motor

Provide Practical Application On:

Figuring the efficiency of and torque produced by a DC motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson Ten

Tools and Equipment:

DC motor circuit

| | |
|---|---|
| **LAB HOURS** | 5 |
| **CLASS HOURS** | 1 |

## EVALUATION (EC-10)

Given a DC circuit with a motor, the student will correctly identify the type of circuit and accurately calculate the efficiency of the motor and its torque at the shaft. One hundred percent accuracy should be achieved.

## TASK

EC-10 Identifying practical applications of DC circuits

## PERFORMANCE OBJECTIVE

Identify practical applications of DC circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Total voltage
b. Terminal voltage
c. Series-parallel circuits applied to DC motors
d. Shunt motor circuit
e. Voltage dividers
f. Basic lighting circuit
g. Three-way switch circuits
h. Four-way switch circuits
i. Efficiency
j. Energy
k. Electrical and mechanical power conversion
l. Torque
    1. Formula wheel
    2. Ohm's law
    3. Power formula

Provide Demonstration On:

a. Figuring efficiency of a DC motor
b. Figuring the torque produced by a DC motor

Provide Practical Application On:

Figuring the efficiency of and torque produced by a DC motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrochemical Action and DC, Lesson Ten

Tools and Equipment:

DC motor circuit

LAB HOURS 5
CLASS HOURS 1

## EVALUATION (EC-10)

Given a DC circuit with a motor, the student will correctly identify the type of circuit and accurately calculate the efficiency of the motor and its torque at the shaft. One hundred percent accuracy should be achieved.

## TASK

AC-01 Identifying characteristics of AC circuits

## PERFORMANCE OBJECTIVE

Identify characteristics of AC circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC vs. AC current flow
b. Wave forms (sine wave)
c. Alternating current cycle
d. AC frequency
e. Maximum and peak-to-peak valves of a sine wave
f. Average valve of a sine wave
g. Effective valve of an AC sine wave
h. Electric field
i. Faraday's law
j. Elementary circuit concepts
k. Resistance
    1. Ohm's law
    2. Joule's law
    3. Lenz's law

Provide Practical Application On:

Defining discussing the following terms
1. AC
2. Sine wave
3. Lenz's law
4. Kirchoff's laws
5. Joule's law
6. Cycle

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits, Lesson One

LAB HOURS 5
CLASS HOURS 5

## EVALUATION (AC-01)

Given specifications for an AC circuit, the student will define and describe the following terms with at least 85% accuracy.

1. Alternating current
2. Sine wave
3. Lenz's law
4. Kirchoff's law
5. Joule's law
6. Cycle

INSTRUCTIONAL ACTIVITIES

Provide Information On:

l. Kirchoff's laws
    1. Current law
    2. Voltage law

m. Current, voltage and resistance in AC circuits

## TASK

AC-02 Identifying sine wave fundamentals

## PERFORMANCE OBJECTIVE

Identify sine wave fundamentals.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. AC voltage sine wave
b. Angles and degrees
   1. Right angles
   2. Cycles (360°)
c. Uses of right triangles
   1. Similar triangles
   2. Total voltage, current and impedance
d. Vectors
   1. Resistance
   2. Reactance
e. Parallelograms
f. Solving AC problems with trigonometry
   1. Sine
   2. Cosine
   3. Tangent

(Continued on back)

Provide Demonstration On:

Working problems for unknowns with a triangle given valves for

1. Angle at origin and opposite side
2. Angle at origin and adjacent side
3. Angle at origin and hypotenuse

Provide Practical Application On:

Working problems with the following givens to solve for unknowns

1. Angle at origin and opposite side

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training System, AC Circuits, Lesson Two

Tools and Equipment:

Table of trigonometric functions

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 5 |

## EVALUATION (AC-02)

Given a tirangle and a table of trigonometric functions, the student will solve for unknown values with values given for
1. Angle of origin and opposite side
2. Angle of origin and adjacent side
3. Angle of origin and hypotenuse
All answers should be 100% accurate.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

4. Angle of origin opposite side, adjacent side

c. Calculating instantanious voltage

Provide Practical Application On:

2. Angle at orgin and adjacent side
3. Angle at origin and hypotenuse

## TASK

AC-03 Calculating inductive reactance

## PERFORMANCE OBJECTIVE

Calculate induction reactance.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Inductance
b. Inductance factors
    1. Coil factors
    2. Magnetic lines of force
    3. Joseph Henry
    4. Self-induction
    5. Mutual induction
c. Self-induction and CEMF
d. Counter or back electromotive force
e. Inductive reactance valves
    1. Inductive reactance
    2. Angular velocity - radians
f. Inductive time delay

(Continued on back)

Provide Demonstration On:

a. Figuring angular velocity
b. Figuring inductive time delay
c. Figuring inductive reactance of a coil

Provide Practical Application On:

Figuring the induction reactance of a coil given the values for inductance, voltage and frequency

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits, Lesson Three

**LAB HOURS** 10

**CLASS HOURS** 5

## EVALUATION (AC-03)

Given a coil and valves for inductance, voltage and frequency, the student will calcualte the inductive reactance of the coil with 100% accuracy.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Phase relationship of voltage and current
h. Factors affecting mutual inductance
    1. Unity coefficient of coupling
    2. Transformer action
i. Inductance in series
j. Inductances in parallel
k. Series - parallel inductances

## TASK

AC-04 Calculating capacitive reactance

## PERFORMANCE OBJECTIVE

Calculate capacitive reactance.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Capacitance and capacitors
b. Actions of capacitors
c. Safety
d. Units of measurement and symbols
    1. Farad
    2. Coulomb
    3. Ampere
    4. Ohms
e. Factors which control capacitance
    1. Plate area
    2. Distance between plates
f. Series-connected capacitors
    1. Decreases total capacitance
    2. Formula

Provide Demonstration On:

a. Calculating capacitive reactance
b. Discharging a capacitor

Provide Practical Application On:

a. Calculating capacitive reactance for a capacitor of known value in an AC circuit of known voltage and frequency
b. Discharging a capacitor in a safe manner

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits, Lesson Four

Tools and Equipment:

a. Capacitors
b. Capacitor circuit

**LAB HOURS** 10
**CLASS HOURS** 5

## EVALUATION (AC-04)

Given an AC circuit of known voltage and frequency with a capacitor of known value, the student will be able to calculate capacitive reactance with 100% accuracy and follow correct safe procedure for discharging the capacitor.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Parallel-connected capacitors
h. Capacitive time constants
i. Capacitive reactance
j. Impedance-capacity vs. frequency
k. Types of capacitors
    1. Mica
    2. Paper
    3. Oil filled
    4. Ceramic
    5. Electrolytic
1. Discharging capacitors
    1. Procedure
    2. Safety

## TASK

AC-05 Identifying and calculating impedance

## PERFORMANCE OBJECTIVE

Identify and calculate impedance in an AC circuit.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Impedance in an AC circuit
b. R and L series circuit impedance
c. RC series circuit impedance
d. LC series circuit impedance
e. RLC series circuit impedance
f. Current-voltage relationship in a series circuit
g. Resistance and inductance in series
h. Resistance and capacitance in series
i. Inductance and capacitance in series

(Continued on back)

Provide Demonstration On:

Calculating impedance in
1. RC series circuits
2. LC series circuits
3. RLC series circuits
4. A parallel circuit

Provide Practical Application On:

Calculating impedance in
1. RC series circuits
2. LC series circuits
3. RLC series circuits
4. Parallel circuits

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits, Lesson Five

**LAB HOURS** 10
**CLASS HOURS** 5

## EVALUATION (AC-05)

Given specifications, the student will calculate impedance in
1. RC series circuits
2. LC series circuits
3. RLC series circuits
4. Parallel circuits

All answers should be 100% correct.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Resistance, inductance and capacitance in series
k. Series circuit resonance
l. Parallel AC circuits

## TASK

AC-06 Identifying practical applications of alternating current

## PERFORMANCE OBJECTIVE

Identify practical applications of alternating current.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Power
b. Positive and negative power
c. Power in resistive circuits
d. Power in an inductive circuit
e. Power in an RL circuit
f. Power factor
g. High and low power factor
    1. Unity power factor
    2. Disadvantages of lower power factor
    3. Reactive power
h. Apparent power and actual power
i. Power factor correction

(Continued on back)

Provide Demonstration On:

a. Figuring the power factor of an AC circuit
b. Using a capacitor to correct the power factor to a specified value

Provide Practical Application On:

Figuring the power factor of an AC circuit and selecting a capacitor to correct the power factor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits, Lesson Six

**LAB HOURS** 5

**CLASS HOURS** 5

## EVALUATION (AC-06)

Given specifications for an AC circuit, the student will accurately calculate the power factor and make a specified correction in the power factor by selecting and installing the appropriate size capacitor.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Power capacitors
k. Capacitor installation
l. Care of capacitors
m. Fusing capacitors
n. Safety precautions

## TASK

AC-07 Identifying polyphase circuits and calculating phase and line voltage

## PERFORMANCE OBJECTIVE

Identify polyphase circuits and calculate phase and line voltage.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Three-phase voltage
b. Y-connected alternator
c. Current in a y-connection
d. Delta-connected alternator
e. Current in a delta connection
f. Three-phase power
g. Y and delta connected leads
h. Power measurements in 3-phase circuits
   1. Three wattmeter method
   2. Two wattmeter method

Provide Demonstration On:

Calculating phase voltage and line voltage
1. Y-connected alternator
2. Delta-connected alternator

Provide Practical Application On:

Calculating phase and line voltage in
1. Y-connected alternator
2. Delta-connected alternator

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricty and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits, Lesson Seven

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 5 |

## EVALUATION (AC-07)

Given specifications for a y-connected alternator and a delta-connected alternator, the student will calculate phase and line voltage with 100% accuracy.

## TASK

AC-08 Identifying principles of transformers

## PERFORMANCE OBJECTIVE

Identify principles of transformers.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The electric field
b. Lines of force
    1. Lines of magnetic force
    2. Faraday's law
    3. Primary and secondary windings
    4. Step-down and step-up transformers
c. Fundamentals of operation
    1. Exciting current
    2. Induced EMF
    3. Calculating the number of windings required for a transformer
d. Operation underload
    1. Lenz's law

(Continued on back)

Provide Demonstration On:

a. Calculating the number of windings required for a specified transformer
b. Calculating
    1. Secondary volt-amperes
    2. Primary volt-amperes
    3. Primary current for a transformer

Provide Practical Application On:

a. Calculating the number of windings required for a specified transformer
b. Calculating for a specified transformer

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits, Lesson Eight

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 1 |

## EVALUATION (AC-08)

Given specifications for a transformer, the student will calculate the number of windings (primary and secondary) required for a specified purpose and calculate secondary volt-amperes, primary volt-amperes and primary current with 100 % accuracy.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

2. Current flow in a transformer under load
3. Calculating
   a. Secondary volt-amperes
   b. Primary volt-amperes
   c. Primary current for a specified transformer

e. Transformer ratings
f. Construction of transformer
   1. Core
   2. Shell
   3. Spira kore
   4. Hipersil
   5. Coils
g. Transformer loss and efficiency
   1. Copper loss
   2. Core loss-hysterisis and eddycurrent
h. Auto transformers
i. Variable auto-transformers
   1. Potential transformers
   2. Current transformers
j. Safety

## TASK

AC-09 Identifying transformer connections, applications and installations

## PERFORMANCE OBJECTIVE

Identify transformer connections, applications and installations.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformer designation
   1. General purpose
   2. Load center
   3. Distribution
   4. Power
   5. Subotation
b. Transformer insulation
   1. Class A
   2. Class B
   3. Class F
   4. Class H
c. Transformer cooling
   1. Dry type
   2. Oil immersed
d. Transformer polarity
e. Single-phase transformer connections

(Continued on back)

Provide Demonstration On:

Installing a transformer

Provide Practical Application On:

Installing a transformer

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits, Lesson Nine

Tools and Equipment:

a. Transformer
b. Circuit
c. Tool kit

| | |
|---|---|
| LAB HOURS | 2 |
| CLASS HOURS | 5 |

## EVALUATION (AC-09)

Given an assigned circuit and a transformer, the student will identify the type of transformer, its proper method of connection and connect the transformer correctly.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Series
    2. Parallel
f. Three-phase transformer connections
    1. Delta-delta connection
    2. Y-y connection
    3. Delta-y (and y-delta)
g. Three-phase transformers
h. Installation of transformers
    1. Procedure
    2. Safety

## TASK

AC-10 Maintaining transformers

## PERFORMANCE OBJECTIVE

Maintain transformers in AC circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformer maintenance procedures
b. Inspection
   1. Lubrication
   2. Blowing off dust
   3. Operating ratio adjusters
c. Specific transformer inspections
d. Transformer liquid test
   1. Dielectric test
   2. Taking oil samples
   3. General testing
e. Transformer torubleshooting
   1. Electrical tests
   2. Disassembly for inspection
   3. Safety

Provide Demonstration On:

a. General transformer maintenance
b. Troubleshooting a faulty transformer

Provide Practical Application On:

a. Performing general transformer maintenance
b. Troubleshooting a faulty transformer

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, AC Circuits Lesson Ten

Tools and Equipment:

a. Transformers
b. Tool kit
c. Oil testers

LAB HOURS 5
CLASS HOURS 5

## EVALUATION (AC-10)

a. Given a transformer, the student will perform all necessary procedures for transformer maintenance including
   1. Lubrication
   2. Cleaning
   3. Operating ratio adjusters

   All procedures should be in accordance with industry safety standards.

b. Given a transformer which is inoperable, the student will troubleshoot and repair the transformer so that it operates efficiently. The student will demonstrate appropriate safety procedures in reparing the transformer.

## TASK

MI-01 Identifying operating principles of electric meters

## PERFORMANCE OBJECTIVE

Identify operating principles of electric meters.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Meter principles
   1. Visual scale
   2. National Bureau of Standards
   3. Ammeter
   4. Voltmeter
   5. Ohmmeter
   6. Megohmmeter

b. Electromagnetic forces

c. Operating principles of the permanent magnet moving coil instrument

d. Moving coil operation

e. Instrument bearings

f. Moving coil clamping

g. Magnetic shielding

h. Parallax errors

(Continued on back)

Provide Demonstration On:

Choosing a meter

Provide Practical Application On:

Choosing a meter for a given application

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics

b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson One

Tools and Equipment:

Several examples of electric meters

**LAB HOURS** 20

**CLASS HOURS** 5

## EVALUATION (MI-01)

Given a specified electrical application, the student will choose the correct type of meter and identify its basic operating principles with 100% accuracy.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Measurement values
j. Shunt construction
k. Shunt connections
l. Voltage measurement
m. Instrument sensitivity
n. Meter accuracy
o. Extending the meter range by the use of shunts

## TASK

MI-02 Identifying and using DC instruments

## PERFORMANCE OBJECTIVE

Identify DC instruments.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC ammeters
b. Extending DC meter ranges
c. Accuracy considerations in choosing a meter
d. DC voltmeters
e. Thermocouple instruments
  1. Construction and operating principle
  2. Applications

Provide Demonstration On:

a. Using a
  1. DC ammeter
  2. DC voltmeter
b. Selecting a meter
c. Measuring KVAR with a thermal meter

Provide Practical Application On:

a. Measuring DC amperage with an ammeter
b. Measuring DC volts with a voltmeter
c. Measuring KVAR with a thermal meter

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson Two

Tools and Equipment:

a. DC ammeter
b. DC voltmeter
c. Thermal meter

| | |
|---|---|
| LAB HOURS | 25 |
| CLASS HOURS | 5 |

## EVALUATION (MI-02)

Given a specific DC circuit measurement to take, the student will choose the correct type of meter and take a reading which is accurate according to industry standards. Readings may be

1. Dc amperage reading
2. DC voltage reading
3. KVAR reading with a thermal meter

## TASK

MI-03 Measuring resistance and insulation

## PERFORMANCE OBJECTIVE

Measure resistance and insulation.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Ohmmeter operating principles
    1. DC source of potential
    2. One or more resistors
b. Ohmmeter calibration
c. Use of the ohmmeter
d. Ohmmeter multiplication features
e. Megohmeter
f. Insulation resistance
g. Proper grounding

Provide Demonstration On:

a. Calibration of an ohmmeter
b. Using an ohmmeter
c. Using a megohmeter
d. Using an insulation tester

Provide Practical Application On:

a. Calibrating and using an ohmmeter
b. Using the megohmeter
c. Using an insulation tester

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson Three

Tools and Equipment:

a. Ohmmeter
b. Megohmmeter
c. Circuits to test

**LAB HOURS** 10

**CLASS HOURS** 10

## EVALUATION (MI-03)

Given an assigned circuit to test, the student will
1. Calibrate and take a reading with an ohmmeter
2. Make a reading with a megohmmeter
3. Use an insulation tester

All readings are to be accurate according to industry standards.

## TASK

MI-04 Identifying operating principles of AC meters

## PERFORMANCE OBJECTIVE

Identify operating principles of AC meters.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Moving-iron metering principles
b. Damping methods
c. Applications of moving-iron meters
d. Inclined coil instruments
e. Electrodynanometer principles
f. Electrodynanometer circuit connections
g. AC meter rectifiers
h. Instrument rectifiers construction

Provide Practical Application On:

Identifying types of AC meters and their operating principles

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., *Basic Electricity/Electronics*
b. Loper, *Introduction to Electricity and Electronics*

Student Manuals:

Plant Engineering Training Systems, *Measuring Instruments, Lesson Four*

Tools and Equipment:

Selection of AC meters

**LAB HOURS** 25
**CLASS HOURS** 5

## EVALUATION (MI-04)

Given an AC meter, the student will correctly identify the type of meter, describe its basic operating principles and identify its applications and usage.

## TASK

MI-05 Selecting a meter and making an AC measurement

## PERFORMANCE OBJECTIVE

Select a meter and make an AC measurement.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Meter selection criteria
b. Split-cone AC instruments
   1. Construction
   2. Use
   3. Measuring voltage and current
c. Instrument transformers
   1. Design of current transformers
   2. Polarity markings
d. Testing current transformers
e. Overload designs
f. Grounding
g. Fusing of instrument voltage transformers
h. Current transformer connections

(Continued on back)

Provide Demonstration On:

a. Selecting a meter
b. Using a clamp-on meter to measure voltage and current
c. Testing current transformers

Provide Practical Application On:

a. Selecting a meter and take a reading of voltage and current
b. Testing a current transformer

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Bergwall, "Basic Electricity and Electronics Explained," filmstrip

Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson Five

Tools and Equipment:

a. Clamp-on meter
b. Transformers
c. Circuits to test

| | |
|---|---|
| **LAB HOURS** | 10 |
| **CLASS HOURS** | 15 |

## EVALUATION (MI-05)

Given a circuit to test, the student will choose the correct type of meter and follow proper procedures to
a. Test current
b. Test voltage
c. Test a current transformer
All readings should be accurate according to industry standards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Safety precautions in testing instrument transformers

## TASK

MI-06 Identifying and using power measuring instruments

## PERFORMANCE OBJECTIVE

Identify and use power measuring instruments.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Wattmeters
b. Wattmeter ratings
c. Measurement of three-phase power
d. Watthour meters
e. Varmeters
f. Demand meters
    1. Watthour-demand meters
    2. Average maximum demand
    3. Demand meter
    4. Demand interval
    5. Maximum demand
    6. Lagged-demand meter
g. Power factor meters
h. Power factor measuring instruments
i. Operating factors
j. Industrial analyzer

(Continued on back)

Provide Demonstration On:

a. Measuring three-phase power with a wattmeter
b. Measuring starting current
c. Measuring voltage

Provide Practical Application On:

a. Measuring three-phase power with a wattmeter
b. Measuring starting current
c. Measuring voltmeter

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson Six

Tools and Equipment:

a. Wattmeter
b. Ammeter
c. Voltmeter

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 10 |

## EVALUATION (MI-06)

Given a circuit to test, the student will accurately measure
a. Three-phase power with a wattmeter
b. Starting current for a motor with an ammeter
c. Voltage with a voltmeter
All measurements will be accurate according to industry standards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Current measurements
l. Voltage measurements

## TASK

MI-07 Identifying and using special measuring instruments

## PERFORMANCE OBJECTIVE

Identify and use special measuring instruments.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The multimeter
    1. DC current measurement
    2. DC voltage measurement
    3. DC resistance measurement
    4. AC voltage measurement
    5. AC resistance measurement
    6. AC current measurement
b. Bridge circuits
c. Wheatstone bridge
d. Capacitance bridge
e. Inductance bridge

Provide Demonstration On:

Using a multimeter

Provide Practical Application On:

Setting the multimeter to read
1. DC current, voltage and resistance
2. AC current, voltage and resistance

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson Seven

Tools and Equipment:

a. Multimeters
b. Circuits to test (AC and DC)

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 15 |

## EVALUATION (MI-07)

Given an AC circuit, a DC circuit and a multimeter, the student will correctly use the multimeter to read current, voltage and resistance for both circuits. All readings should be accurate according to industry standards.

## TASK

MI-08 Identifying and using indicating instruments

## PERFORMANCE OBJECTIVE

Identify and use indicating instruments.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Indicating instruments
    1. Purpose
    2. Types
b. Wiggy
c. Fuse pullers
d. Continuity testers
    1. Types
    2. Uses
e. Rotation tester
f. Phase sequence indicator
g. Synchronizing
h. Synchroscope
i. Frequency meters
j. Growler
    1. Construction
    2. Use

Provide Demonstration On:

a. Using a wiggy voltage tester
b. Using a fuse puller to replace a fuse
c. Using a rotation tester to check a motor
d. Checking a motor with a growler

Provide Practical Application On:

a. Using a wiggy voltage tester to test voltage
b. Pulling a fuse with a fuse puller

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson Eight

Tools and Equipment:

a. Wiggy voltage testers
b. Fuse pullers
c. Rotation tester
d. Growler
e. Circuits and motors

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 10 |

## EVALUATION (MI-08)

Given a circuit with a motor, a voltage tester, fuse puller, rotation tester and a growler, the student will perform the following operations

1. Test for voltage with a wiggy voltage tester
2. Pull a fuse with a fuse puller
3. Use a rotation tester to check motor rotation
4. Use a growler to check a motor armature

All operations will be performed in accordance with industry standards.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Using a rotation tester to check rotation of a motor
d. Checking a motor with a growler

# TASK

MI-09 Identifying recording instruments and procedures for instrument care and maintenance

# PERFORMANCE OBJECTIVE

Identify recording instruments and procedures for instrument care and maintenance.

# INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Recording instruments
   1. Electrical quantities
   2. Non-electrical quantities through the application of electrical systems
   3. Non-electrical quantities by mechanical means
b. Strip-chart recorders
   1. Construction
   2. Operation
   3. Inking system
c. Inkless recorders
d. Round-chart records
e. Care and maintenance of instruments

(Continued on back)

Provide Demonstration On:

Checking and servicing
1. Strip-chart recorders
2. Round-chart recorders
3. Strobscope

Provide Practical Application On:

Checking and servicing
1. Strip-chart recorders
2. Round-chart recorders
3. Strobscope

# INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson Nine

Tools and Equipment:

a. Strip-chart recorder
b. Round-chart recorder
c. Strobscope
d. Multimeter

**LAB HOURS** 20

**CLASS HOURS** 15

## EVALUATION (MI-09)

Given a multimeter and necessary supplies and tools, the student will adjust and maintain the following types of recording instruments according to manufacturer's specifications.
1. Strip-chart recorder
2. Round-chart recorder
3. Strobscope

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Operating maintenance
    2. Instrument corrections
    3. Safety precautions
f. Strobscope
    1. Operating principles
    2. Uses
    3. Surface-speed wheel

## TASK

MI-10 Identifying and using electronic measuring instruments

## PERFORMANCE OBJECTIVE

Identify and use electronic measuring instruments.

## INSTRUCTIONAL ACTIVITIES

### Provide Information On:

a. Vacuum-tube voltmeter
    1. Construction
    2. Similarities to VOM
    3. Advantages and disadvantages
    4. AC voltage measurement
    5. Resistance measurements
b. Oscilloscope
    1. Construction
    2. Operating principle
c. Using the oscilloscope
    1. Amplitude
    2. Frequency
    3. Wave form
    4. Phase
    5. Peak valves and peak-to-peak valves
    6. Sweep
    7. Intensity and focus controls

### Provide Demonstration On:

a. Using a VTVM
    1. Reading AC voltage
    2. Resistance
b. Using the oscilloscope
    1. Amplitude
    2. Frequency
    3. Wave form
    4. Phase

### Provide Practical Application On:

a. Using a VTVM to read
    1. AC voltage
    2. Resistance
b. Using an oscilloscope
    1. Amplitude
    2. Frequency
    3. Wave form
    4. Phase

## INSTRUCTIONAL MATERIALS

### Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

### Student Manuals:

Plant Engineering Training Systems, Measuring Instruments, Lesson Ten

### Tools and Equipment:

a. VTVM
b. Oscilloscope
c. AC circuit

| | |
|---|---|
| **LAB HOURS** | 25 |
| **CLASS HOURS** | 10 |

## EVALUATION (MI-10)

Given an AC circuit, VTVM and an oscilloscope, the student will follow correct procedures to use the VTVM to read AC voltage and resistance. The student will use the oscilloscope to read amplitude, frequency, wave form and phase. All readings will be in accordance with industry standards.

## TASK

PD-01 Identifying and maintaining protective devices

## PERFORMANCE OBJECTIVE

Identify and maintain protective devices.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Function of a fuse
b. Lead link fuses
c. Cartridge fuses
    1. Renewable fuse link type
    2. One-time fuses
d. Fuse link
e. Dual element cartridge fuse
f. Current limiting fuses
g. Let-thru current
h. Cartridge fuse clans, size and rating
i. Power fuses
j. Installation of fuses
    1. Procedure
    2. Safety
    3. NEC rules

Provide Demonstration On:

Installing fuses with correct size fuse

Provide Practical Application On:

Replacing a fuse in a circuit with the correct size fuse

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson One

Tools and Equipment:

a. Fuses
b. Fused circuits
c. Tool kit

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 10 |

## EVALUATION (PD-01)

Given a fused circuit, the student will install a fuse in accordance with NEC rules.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Plug fuses
l. NEC rules for plug fuses
m. Glass-tube fuses
    1. Fast-blo
    2. Slo-blo

## TASK

PD-02 Identifying and maintaining circuit breakers

## PERFORMANCE OBJECTIVE

Identify and maintain circuit breakers.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Basic principles of circuit breakers
b. Types of circuit breakers
    1. Thermal circuit breakers
    2. Magnetic circuit breakers
    3. Thermal-magnetic circuit breakers
    4. Ambient compensating circuit breaker
    5. Molded case circuit breakers
d. Maintenance of molded case circuit breakers
e. Switch gear
    1. Circuit breaker
    2. Control devices

(Continued on back)

Provide Demonstration On:

Maintaining circuit breakers

Provide Practical Application On:

Checking a tripped circuit breaker and returning the circuit to normal operation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson Two

Tools and Equipment:

Circuit breaker circuit

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 15 |

## EVALUATION (PD-02)

Given an AC circuit with a circuit breaker, the student will check the course for a tripped circuit breaker and restore the circuit to normal operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

3. Purpose of switch gear

f. Low voltage power circuit breakers
g. Stored energy mechanism
h. Manual operation
i. Electrical operation
j. Circuit breaker tripping
k. Safety

## TASK

PD-03 Identifying and maintaining overload relays

## PERFORMANCE OBJECTIVE

Identify and maintain overload relays.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Fuse protection
b. Motor protection
c. Motor temperature monitoring protectors
d. Motor current sensing devices
    1. Thermal overload relay
    2. Trip-free relays
e. Melting alloy relay
f. Bimetallic relay
g. Factors in selection of motor protection
h. Compensating overload relay
i. Single phasing
j. Overload relay protection
k. Maintenance of motor overload relays

(Continued on back)

Provide Demonstration On:

a. Selecting motor protection
b. Maintaining motor overload relays

Provide Practical Application On:

Maintaining a motor overload relay by
1. Cleaning
2. Tightening connections
3. Inspecting heater size

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson Three

Tools and Equipment:

a. Motor circuit with overload relays
b. Tool kit

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 10 |

## EVALUATION (PD-03)

Given a motor circuit with an overload relay, the student will correctly identify its type, describe its operation and perform the maintenance functions of cleaning, tightening connections and inspecting heater size.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

1. Cleaning
2. Tightening connections
3. Inspecting heater size

## TASK

PD-04 Identifying applications of protective devices

## PERFORMANCE OBJECTIVE

Identify applications of protective devices.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Branch circuits
   1. NEC definition
   2. Purpose
   3. Individual branch circuit
   4. Multiwire branch circuit
b. Protection of branch circuit conductors
   1. NEC requirements
   2. Devices
c. Thermal devices
d. Underground conductors
e. Grounded conductors
f. Fuse or circuit breakers in parallel

(Continued on back)

Provide Demonstration On:

Selecting and installing protective devices in an AC circuit

Provide Practical Application On:

Selecting and installing appropriate protective devices in an assigned AC circuit

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson Four

Tools and Equipment:

a. Various AC protective devices
b. Circuits
c. Tool kits

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 10 |

## EVALUATION (PD-04)

Given an assigned AC circuit and all necessary tools and equipment, the student will select and install the appropriate protective devices in the circuit. The completed task must be in compliance with NEC standards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Location of overcurrent devices
h. Enclosures for overcurrent devices
i. Disconnecting and guarding overcurrent devices
j. Motor running protection
k. Feeder size
l. Motor branch circuit overcurrent protection
m. Selecting motor running overcurrent protection
n. Inherent protection
o. In-motor temperature detectors
p. Temperature detectors

## TASK

PD-05 Grounding AC circuits

## PERFORMANCE OBJECTIVE

Ground AC circuits according to industry standards.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Circuit grounding
b. Transformer grounding
c. Effects of impedance
d. Grounding through enclosure
e. Visual indication of ground
f. Grounded conductor alarms
g. Detecting ground faults automatically
h. Ground alarm circuit operation

Provide Practical Application On:

Describing grounding for a given AC circuit

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., *Basic Electricity Electronics*
b. Loper, *Introduction to Electricity and Electronics*

Student Manuals:

Plant Engineering Training Systems, *Protective Devices, Lesson Five*

**LAB HOURS** 10
**CLASS HOURS** 10

**EVALUATION** (PD-05)

Given an AC circuit, the student will correctly identify and describe the method of grounding necessary for the circuit.

## TASK

PD-06 Identifying applications of the National Electrical Code

## PERFORMANCE OBJECTIVE

Identify applications of the National Electrical Code.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. NEC Handbook contents
b. General requirements of the code
c. Use and identification of grounded conductors
d. Identification of terminals
e. Wire color code
f. Wiring methods
g. Conductors
h. Electrical continuity of metal raceways and enclosures
i. Conductors for general wiring
j. Rigid metal conduit
k. Electrical metallic tubing
l. Flexible metal conduit

(Continued on back)

Provide Practical Application On:

Identifying sections of the NEC Handbook which apply to assigned electrical tasks

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics
c. NEC Handbook

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson Six

| | |
|---|---|
| LAB HOURS | 0 |
| CLASS HOURS | 30 |

**EVALUATION** (PD-06)

Given an assignment which relates to electrical construction, the student will identify the appropriate sections of the NEC Handbook which apply to the job and accurately define the meaning of each of the NEC regulations.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

m. Flexible cords and cables
n. Lamp fixture wiring
o. Fixture support
p. Fixture installation

## TASK

PD-07 Making basic electrical calculations

## PERFORMANCE OBJECTIVE

Make basic calculations for electrical construction.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Basic calculations
    1. Power formula
    2. Kirchoff's laws of voltage
    3. Ohm's law
b. Determining conduit fill
    1. NEC rules
    2. Procedures for determining conduit fill
c. Mixing conductor sizes
d. Junction box size
e. Pull box sizes
f. Auxiliary gutter sizes
g. Feeder neutral sizes

Provide Demonstration On:

a. Determining conduit fill
b. Choosing the appropriate junction box size
c. Choosing the appropriate pull box size
d. Choosing auxiliary gutter sizes
e. Calculating feeder neutral sizes

Provide Practical Application On:

Determining
1. Conduit fill
b. Junction box size
c. Pull box size
d. Feeder neutral size

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics
c. NEC Handbook

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson Seven

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 10 |

**EVALUATION** (PD-07)

Given specifications for a job, the student will calculate
1. Junction box size
2. Pull box size
3. Auxiliary gutter size
4. Feeder neutral size

All calculations will be in accordance with NEC regulations.

## TASK

PD-08 Identifying wireway systems

## PERFORMANCE OBJECTIVE

Identify wireway systems.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Switches
b. Knife switches
c. Switch chassifications
    1. General use switch
    2. Motor circuit switch
    3. Safety switch
    4. NEMA classifications
d. Magnetic switches
e. NEMA enclosure classifications for electrical devices
f. Wireways
g. Underfloor raceways
h. Cellular metal-floor raceways

(Continued on back)

Provide Demonstration On:

a. Determining NEMA switch classifications
b. Determining NEMA enclosure classifications

Provide Practical Application On:

Determining NEMA classifications for switches and electrical enclosures

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics
c. NEC Handbook
d. Manufacturer's catalogs

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson Eight

Tools and Equipment:

a. Switches
b. Electrical enclosures

**LAB HOURS** 10
**CLASS HOURS** 10

## EVALUATION (PD-08)

Given a selection of switches, electrical enclosures and appropriate manufacturer's catalogs, the student will correctly determine the NEMA classifications of the switches and enclosures and describe their applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Cellular concrete floor raceways
j. Busways
k. Cablebus
l. Surface metal raceway

## TASK

PD-09 Identifying methods of industrial illumination

## PERFORMANCE OBJECTIVE

Identify methods used for industrial illumination.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Basic principles of vision
b. Behavior of light
    1. Wave length
    2. Reflection and absorption
    3. Specular reflection
    4. Diffuse reflection
c. Light measurement
    1. Candle power
    2. Lumens
    3. Foot candles
d. Inverse-square law
e. Measurement of foot candles
    1. Lightmeter
    2. Foot lamberts
    3. Lumens-per-watt
f. Electric light sources

(Continued on back)

Provide Demonstration On:

a. Calculating foot candles
b. Troubleshooting a lighting system
c. Replacing bulbs
d. Using a light meter

Provide Practical Application On:

a. Calculating foot candles of illumination
b. Troubleshooting and maintaining a lighting system
c. Using a light meter to determine illumination

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson Nine

Tools and Equipment:

a. Light meter
b. Lighting system

**LAB HOURS** 10
**CLASS HOURS** 10

## EVALUATION (PD-09)

Given an industrial illumination system and specifications, the student will

1. Calculate illumination in foot-candles
2. Use a light meter to determine level of illuminatin
3. Perform simple troubleshooting and maintenance on the system

All calculations should be 100% accurate.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

    1. Incandescent lamps
    2. Fluorescent lamps
g. Mercury-vapor lamp
    1. Construction
    2. Designations
h. Luminaire
i. Emergency lighting
j. Lighting maintenance
k. Lamp safety

## TASK

PD-10 Identifying procedures for electrical safety and maintenance

## PERFORMANCE OBJECTIVE

Identify procedures for electrical maintenance and safety.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Importance of electrical safety
   1. Shock
   2. Prevention
   3. Fist aid
b. Electrical safety lock-out
c. Power equipment safety
d. Portable power tool safety
e. Personal safety
f. Specific safety rules for
   1. Electrical circuits
   2. Operation of switches
   3. Handling fuses
   4. Motors and switchboards
g. Moving and lifting equipment

Provide Practical Application On:

Identifying safety procedures for an assigned job

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Power Tool Safety and Operation," transparencies

Student Manuals:

Plant Engineering Training Systems, Protective Devices, Lesson Ten

**LAB HOURS** 10

**CLASS HOURS** 10

## EVALUATION (PD-10)

Given specific details for an assigned maintenance job, the student will identify all safety precautions and protective devices required for safe execution of the job.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Eye injuries
i. Fire prevention
j. Scaffolds and ladder

## TASK

DC-01 Identifying sources of DC power in industry

## PERFORMANCE OBJECTIVE

Identify sources of DC power in industry.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC generators
b. DC rectifiers
c. DC motors
d. SCR speed control
e. Storage batteries
f. Storage battery chargers
g. Electroplating
h. Low-voltage, high-current devices
i. Electropolishing
j. Electroforming
k. Electrolytic refining
l. Electrolytic furnaces
m. Arc-welding

Provide Practical Application On:

a. Defining and describing the following processes
    1. Electroplating
    2. Electroforming
    3. Electrolytic refining
    4. Arc-welding
b. Identifying principles of DC
    1. DC generator
    2. DC rectifiers
    3. DC motors

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson One

**LAB HOURS** 15
**CLASS HOURS** 5

## EVALUATION (DC-01)

Given the following terms, the student will identify and describe the following terms, devices and/or processes
1. DC generators
2. DC motors
3. Electroplating
4. Electroforming
5. Electropolishing
6. Electrolytic refining
7. Arc-welding

All definitions/descriptions shall be accurate to 80%.

## TASK

DC-02 Identifying principles and applications of electromagnetism in DC circuits

## PERFORMANCE OBJECTIVE

Identify principles and applications of electromagnetism in DC circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Magnets and magnetic materials
b. Magnetic attraction and repulsion
c. Lines of force
d. Effects of air gaps
e. Magnetic shields
f. Solenoids
g. U-shaped magnets
h. Reducing the effects of residual magnetism
i. Laminations
j. Solenoid applications
k. Relays
l. Polarized relays
m. Relay contact protection

Provide Demonstration On:

a. Basic electromagnetic action
b. Choosing a solenoid

Provide Practical Application On:

Choosing a solenoid for a given application

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Two

Tools and Equipment:

a. DC circuit
b. Solenoids

**LAB HOURS** 15

**CLASS HOURS** 5

## EVALUATION (DC-02)

Given a DC circuit with a requirement for a solenoid, the student will accurately describe the basic principles of electromagnetic action in the solenoid and choose the correct solenoid for the circuit.

## TASK

DC-03 Identifying applications of DC generators

## PERFORMANCE OBJECTIVE

Identify applications of DC generators.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC generator construction
   1. Armature
   2. Field poles and frame
   3. End plates
   4. Brushes
   5. Brush rigging
b. Generator action
   1. Prime mover
   2. Electromagnetic induction
c. A simple DC generator
d. Generator voltage
e. Armature reaction
f. Commutation
g. Interpoles
h. Separately excited generators

(Continued on back)

Provide Demonstration On:

a. Calculating DC generator terminal voltage
b. Reading DC generator circuit diagrams

Provide Practical Application On:

a. Calculating DC generator terminal voltage
b. Reading DC generator circuits diagram and identifying the type of DC generator

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Three

Tools and Equipment:

DC circuit diagrams

| | |
|---|---|
| **LAB HOURS** | 15 |
| **CLASS HOURS** | 15 |

## EVALUATION (DC-03)

Given specifications for a DC generator circuit and a circuit diagram, the student will correctly identify the type of generator and circuit and figure the terminal voltage of the DC generator with 100% accuracy.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Self-excited shunt generator
j. Series generator
k. Compound generators
l. Generator losses
m. Eddy currents
n. Hysterisis loss
o. Mechanical losses
p. Parallel operation of generators

## TASK

DC-04 Identifying principles and applications of DC motors

## PERFORMANCE OBJECTIVE

Identify principles and applications of DC motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Principle of DC motor action
b. Counter electromotive force (CEMF)
c. Armature reaction
d. Self-induction and commutation
e. Interpoles
f. DC motor torque
g. DC motor horsepower
h. Speed regulation of DC motors
i. Types of DC motors
    1. Shunt motor
    2. Torque variation in a shunt motor
    3. Effects of an open shunt field

(Continued on back)

Provide Demonstration On:

a. Calculating counter electromotive force
b. Calculating speed regulation of a DC motor

Provide Practical Application On:

a. Calculating the CEMF of a specified electric DC motor
b. Calculating the speed regulatory of a specified DC motor
c. Identifying types of DC motors

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Four

Tools and Equipment:

Selection of DC motors

**LAB HOURS** 15

**CLASS HOURS** 10

## EVALUATION (DC-04)

Given a specified DC motor, the student will accurately identify the type of motor and calculate counter electromotive force and speed regulation with 100% accuracy.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

4. Series motor
5. Compound motors
6. Cumulative compound motors
7. Differential compound motors
8. Reversing the rotation of DC motors

## TASK

DC-05 Identifying types of DC armatures and maintaining them

## PERFORMANCE OBJECTIVE

Identify types of DC armatures and maintain them.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC armature types
    1. Gramme-ring
    2. Drum
b. DC armature windings
    1. Pole pitch
    2. Lap windings
    3. Wave windings
c. Simplex lap windings
d. Simplex wave windings
e. Armature losses
    1. Copper loss
    2. Eddy current loss
    3. Hysteresis loss
f. Commutation
g. Armature maintenance
    1. Routine maintenance
    2. Troubleshooting

Provide Demonstration On:

a. Performing armature maintenance
b. Troubleshooting a faulty armature

Provide Practical Application On:

a. Performing routine armature maintenance
b. Troubleshooting a faulty armature

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Five

Tools and Equipment:

a. Armature
b. VOM

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 10 |

## EVALUATION (DC-05)

Given a VOM and two armatures, one of which is faulty, the student will correctly identify the types and perform routine maintenance including inspection, cleaning and troubleshooting.

## TASK

DC-06 Identifying types and operating principles of DC relays

## PERFORMANCE OBJECTIVE

Identify types and operating principles of DC relays.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Relay principles
b. Relay operating characteristics
c. Overload relays
d. Dashpot time - delay relays
e. Dashpot applications
f. Types of relays
    1. Shunt relays
    2. Series lockout relays
    3. Double-coil series lockout relays
    4. Two-coil lockout relays
    5. Special lockout control relays
    6. Inductive time-delay relays

(Continued on back)

Provide Practical Application On:

Identifying types of relays and describing their operating principles

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Six

Tools and Equipment:

Selection of various types of relays

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 10 |

## EVALUATION (DC-06)

Given a selection of relays, the student will correctly identify the types and describe their operating principles.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Dynamic braking
h. Electrically operated brakes
i. Disc brakes
j. Magnetic blowout coils

## TASK

DC-07 Identifying DC controllers and their operating principles

## PERFORMANCE OBJECTIVE

Identify DC controllers and their operating principles.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC controller classifications
   1. Motor-starting
   2. Motor-starting and reversing
   3. Motor-starting and speed
   4. Motor-starting and speed selection
   5. Motor-starting and reversing and speed selection
   6. Across-the-line
   7. Resistor
   8. Adjustable voltage

b. Controller ratings

(Continued on back)

Provide Demonstration On:

Reading schematics for DC controllers circuits

Provide Practical Application On:

Reading a schematic for a DC controller circuit and identifying the type/classification of controller

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Seven

Tools and Equipment

Schematics of DC controller circuits

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 15 |

## EVALUATION (DC-07)

Given a schematic of a DC controller circuit, the student will accurately identify its type/classification and describe its operating principle.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

c. DC motor speed
d. Performance classification
    1. Manual
    2. Semiautomatic
    3. Automatic
e. Overvoltage protection
f. Low voltage release
g. Low voltage release effect
h. Overload protection
i. Overload relay characteristics
j. Temperature-compensated thermal overload relays
k. Controller overload reset
l. Manual starters
    1. Three-point starters
    2. Four-point starters
m. Magnetic controllers
n. Drum controllers
o. Reversing DC drum starter operation
p. DC controller schematics

## TASK

DC-08 Identiyfing and maintaining DC power supplies

## PERFORMANCE OBJECTIVE

Identify and maintain DC power supplies.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Electron emission
b. Electron tubes
    1. Diodes
    2. Cathode and anode
c. Diode circuits
d. Mercury-vapor diodes
e. Semiconductors
f. Generators and rectifiers compared
g. Automotive AC/DC power supplies
h. Semiconductor failure
i. JEDEC numbers for diodes

Provide Demonstration On:

a. Reading a diode circuit schematic
b. Troubleshooting diodes
c. Identifying and replacing semiconductor

Provide Practical Application On:

a. Troubleshooting semiconductor circuit with a faulty component
b. Replacing the component with an appropriate replacement part

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Eight

Tools and Equipment:

a. VOM
b. Semiconductor circuits
c. Schematics
d. Tool kit (includes soldering tools)

| | |
|---|---|
| **LAB HOURS** | 10 |
| **CLASS HOURS** | 15 |

## EVALUATION (DC-08)

Given a faulty semiconductor circuit, schematic and a VOM, the student will troubleshoot the circuit, identify the faulty semiconductor and correctly replace the semiconductor.

## TASK

DC-09 Identifying principles and applications of silicon controlled rectifiers (SCR)

## PERFORMANCE OBJECTIVE

Identify principles and applications of silicon controlled rectifiers.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Silicon controlled rectifiers
b. SCR pulse timing in DC circuits
c. SCR trigger pulses
d. SCR DC motor control
e. DC applications of the SCR
f. AC/DC conversion with SCR
g. AC applications of the SCR
h. SCR circuit schematics

Provide Demonstration On:

Reading SCR circuit schematics

Provide Practical Application On:

a. Reading an SCR circuit schematic
b. Discribing the application of the SCR
c. Describing the operating principle of the SCR

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Nine

Tools and Equipment:

SCR circuit schematics

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 10 |

## EVALUATION (DC-09)

Given an SCR circuit schematic, the student will accurately identify its type of application and describe its operating principle.

## TASK

DC-10 Performing basic DC circuit maintenance

## PERFORMANCE OBJECTIVE

Perform basic DC circuit maintenance.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Equipment inspection procedures
b. Field coil care
c. Locating field coil troubles
d. Short-circuited field coils
e. Open field coild
f. Field coil replacement
g. DC motor controllers
h. Relay care
i. Relay contacts
j. DC armature care
k. Commutation
l. Commutator maintenance
m. Brush selection and maintenance

Provide Demonstration On:

a. Replacing a field coil
b. Setting brushes
c. Troubleshooting a DC circuit

Provide Practical Application On:

Troubleshooting and repairing a DC circuit

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, DC Equipment and Controls, Lesson Ten

Tools and Equipment:

a. DC circuits
b. VOM
c. Tool kit
d. Schematics

**LAB HOURS** 20

**CLASS HOURS** 10

## EVALUATION (DC-10)

Given a faulty DC circuit and necessary tools and schematics, the student will troubleshoot the circuit and restore it to proper operation.

## TASK

SP-01 Identifying basic operating principles of single-phase motors

## PERFORMANCE OBJECTIVE

Identify basic operating principles of single-phase motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Parts of a single-phase motor
b. Motor terminology
c. NEMA motor standards
d. Motor enclosures
    1. Open motors
    2. Totally enclosed motors
e. Motor nameplate data
f. Induction motors
g. Single-phase stator field
h. Stator field
i. Rotor field
j. Split-phase starting
k. Poles
l. Electrical degrees
m. Synchronous speed

(Continued on back)

Provide Demonstration On:

a. Reading a motor nameplate
b. Calculating electrical degrees of a motor
c. Calculating synchronous speed of a motor

Provide Practical Application On:

a. Reading the nameplate and interpreting data
b. Identifying motor type
c. Calculating electrical degrees
d. Calculating synchronous speed

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Career Aids, Inc., "How Electric Motors Start and Run," slide/tape; filmstrip

Student Manuals:

Plant Engineering Training Systems, Single Phase Motors, Lesson One

Tools and Equipment:

Electric motors (single-phase)

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 8 |

## EVALUATION (SP-01)

Given a single-phase motor, the student will read and interpret the data on the motor nameplate, identify the type of motor, calculate electrical degrees and calculate the synchronous speed of the motor with 100% accuracy.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

n. Starting switches
o. Standard and special split-phase motors
p. Motor bearings

## TASK

SP-02 Identifying and maintaining split-phase motors

## PERFORMANCE OBJECTIVE

Identify and maintain split-phase motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Single-phase motor starting
b. Stator windings
c. Split-phase starting
d. Split-phase motor connections
e. Motor lead color codes
f. Split-phase motor winding connections
g. Skein winding
h. Consequent-pole windings
i. Two-speed, split-phase motor
j. Two-speed, three-winding split-phase motors
k. Two-speed, four-winding, split-phase motors

(Continued on back)

Provide Demonstration On:

a. Hooking up a split-phase motor
b. Troubleshooting split-phase motors

Provide Practical Application On:

a. Hooking up a split-phase motor
b. Troubleshooting a split-phase motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Single-Phase Motors, Lesson Two

Tools and Equipment:

a. Split-phase motor
b. VOM
c. Tool kit

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 5 |

## EVALUATION (SP-02)

Given a faulty split-phase motor, tool kit and VOM, the student will correctly hook up the motor, troubleshoot the motor and identify and correct the problem so that the motor operates normally.

### INSTRUCTIONAL ACTIVITIES

Provide Information On:

l. Dual voltage split-phase motors
m. Split-phase motor trouble-shooting
n. Using the VOM
o. Open-circuit winding
p. Shorted turns in a windings
q. Motor will not start
r. Motor runs slower than normal

## TASK

SP-03 Identifying and maintaining capacitor motors

## PERFORMANCE OBJECTIVE

Identify and maintain capacitor motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of capacitor start motors
    1. Capacitor start
    2. Permanent-split capacitor
    3. Two-capacitor
b. Capacitors
c. Capacitor-start motor principles of operation
d. Rotating magnetic fields
e. Connections for a capacitor-start motor
f. Single-voltage reversible capacitor motors
g. Single-voltage, three-lead capacitor motors

(Continued on back)

Provide Demonstration On:

a. Hooking up a capacitor-start motor
b. Troubleshooting a capacitor motor
c. Replacing a capacitor

Provide Practical Application On:

a. Hooking up and troubleshooting a capacitor motor
b. Replacing a capacitor on a motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Single-Phase Motors, Lesson Three

Tools and Equipment:

a. Capacitor motors
b. VOM
c. Tool kit
d. Capacitors

**LAB HOURS** 10

**CLASS HOURS** 5

## EVALUATION (SP-03)

Given a faulty capacitor motor, the student will correctly hook up the motor, troubleshoot the fault, correctly replace a capacitor and restore the motor to normal operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Instantly-reversible capacitor motor
i. Dual voltage capacitor motor
j. Capacitor-start, capacitor-run motor
k. Permanent split capacitor motor
l. Reversible capacitor-run motor
m. Two-speed capacitor-run motor
n. Troubleshooting capacitor motors
    1. Defective capacitors
    2. Capacitor replacement
o. Rules for combining capacitors

## TASK

SP-04 Identifying and maintaining repulsion motors

## PERFORMANCE OBJECTIVE

Identify and maintain repulsion motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of repulsion motors
b. Repulsion motor characteristics
c. Repulsion-start, induction-run motors
d. Repulsion principle
e. Hard and soft neutral plane
f. Induction running
g. Purpose of brushes
h. Short-circuiter
i. Commutator
j. Brush-lifting mechanism
k. Brush-riding motor
l. Brush holders
m. Brush neutral setting
n. Brush replacement
o. Repulsion motor

(Continued on back)

Provide Demonstration On:

a. Replacing brushes in a repulsion motor
b. Troubleshooting repulsion motors

Provide Practical Application On:

Troubleshooting and repairing a faulty repulsion motor including brush replacement

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Single-Phase Motors, Lesson Four

Tools and Equipment:

a. Repulsion motors
b. VOM
c. Tool kit
d. Brushes

| | |
|---|---|
| **LAB HOURS** | 10 |
| **CLASS HOURS** | 5 |

## **EVALUATION** (SP-04)

Given a faulty repulsion motor, tool kit, brushes and a VOM, the student will identify the type of motor, troubleshoot and repair the motor, include brush replacement and restore the motor to normal operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

p. Compensated repulsion motor
q. Repulsion-induction motor
r. Plugging operation
s. Stator windings
t. Armature windings
u. Equalizer connections
v. Wave-sound armatures
w. Troubleshooting and maintenance

## TASK

SP-05 Identifying and maintaining universal motors

## PERFORMANCE OBJECTIVE

Identify and maintain universal motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. DC shunt motors operated on AC
- b. DC series motors operation on AC
- c. Hysterisis and eddy current losses
- d. Universal motors
  - 1. Ratings
  - 2. Performance characteristics
  - 3. Operating characteristics
  - 4. Speed control
- e. Universal motor assemblies
- f. Housing and assemblies
- g. Ventilation
- h. Motor life

(Continued on back)

Provide Demonstration On:

- a. Selecting and mounting brushes on a universal motor
- b. Troubleshooting and repairing a universal motor

Provide Practical Application On:

Troubleshooting and repairing a faulty universal motor including brush replacement

## INSTRUCTIONAL MATERIALS

Textbooks:

- a. Training and Retraining, Inc., Basic Electricity/Electronics
- b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Single Phase Motors, Lesson Five

Tools and Equipment:

- a. Universal motor
- b. VOM
- c. Tool kit
- d. Brushes

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 5 |

## EVALUATION (SP-05)

Given a faulty universal motor, VOM, tool kit and brushes, the student will hook up, troubleshoot and repair the motor.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Brush selection and mounting
j. Speed reducers
k. Electrical connections
l. Troubleshooting and repair

## TASK

SP-06 Identifying special purpose single-phase motors

## PERFORMANCE OBJECTIVE

Identify types of special purpose single-phase motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Shaded-pole motors
    1. Principles of operation
    2. Reversing shaded-pole motors
    3. Features
b. Synchronous motors
c. Hysterisis motors
d. Unexcited synchronous motors
e. Inductor motors
f. Permanent magnet motors
g. Reluctance motors

Provide Practical Application On:

Identifying types of special purpose motors and describing their principles of operation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Single-Phase Motors, Lesson Six

Tools and Equipment:

Selection of special purpose motors

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 8 |

## EVALUATION (SP-06)

Given a selection of special purpose motors, the student will identify each type and correctly describe its principle of operation.

## TASK

SP-07 Identifying synchro systems and applications

## PERFORMANCE OBJECTIVE

Identify synchro systems and their applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Synchro systems
b. Rotor construction
c. Stator construction
d. Synchro assembly
e. Synchro transmitter operation
f. Terminal-to-terminal voltages
g. Receivers
h. Synchro system schematics
i. Synchro transmission systems
j. Reversing direction of receiver rotation
k. Torque differential synchros
l. Differential receivers

(Continued on back)

Provide Demonstration On:

Reading a synchro system schematic

Provide Practical Application On:

Reading a synchro system schematic and identifying the type of system and its operating principles

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Single-Phase Motors, Lesson Seven

Tools and Equipment:

Synchro system schematics

LAB HOURS 10
CLASS HOURS 10

## EVALUATION (SP-07)

Given a synchro system schematic, the student will read the schematic, identify the type of system and correctly describe its principles of operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

m. TX-TDX-TR synchro systems
n. Adding and subtracting by differential transmitters
o. Control synchro systems
p. Control transformer
q. CT stator voltages
r. Operation of a CT with a synchro transmitter

## TASK

SP-08 Identifying servomechanisms and their principles of operation

## PERFORMANCE OBJECTIVE

Identify servomechanisms and their principles of operation.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Servomechanisms
   1. Purpose
   2. Operation
b. Input controllers
c. Output controllers
d. Amplidynes
   1. Purpose
   2. Operation
e. Overtravel control
f. DC servomotors
g. AC servomotors
h. Servocontrol bridges
i. Servoactuators
j. Servomechanism schematics

Provide Demonstration On:

Reading servomechanism schematics

Provide Practical Application On:

Reading servomechanism schematic and identifying the type of mechanism and its principle of operation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Single-Phase Motors, Lesson Eight

Tools and Equipment:

Servomechanism schematics

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 10 |

## EVALUATION (SP-08)

Given a schematic of a servomechanism, the student will read the schematic, identify the type of mechanism and correctly describe its principle of operation.

## TASK

SP-09 Identifying starting and protection devices for single-phase motors

## PERFORMANCE OBJECTIVE

Identify starting and protection devices for single-phase motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Single-phase motor protection
b. Size of circuit conductors
c. Protection against shorts and grounds
d. Single-phase motor controllers
e. Short circuit and ground faulty protection
f. Disconnecting means for safety
g. Guards and grounding
h. NEC requirements
i. Selecting fuse size
j. Sizing single-phase motor feeders
k. Manual single-phase starters

(Continued on back)

Provide Demonstration On:

a. Selecting appropriate fuse size
b. Calculating service factor
c. Selecting a motor

Provide Practical Application On:

Selecting the appropriate size and type of
1. Protection device
2. Feeder
3. Motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics
c. NEC Handbook

A/Vs:

Career Aids, Inc., "How Electric Motors Start and Run," slide/tape; filmstrip

Student Manuals:

Plant Engineering Training Systems, Single-Phase Motors, Lesson Nine

| | |
|---|---|
| LAB HOURS | 5 |
| CLASS HOURS | 10 |

## EVALUATION (SP-09)

Given a specified application, the student will select the appropriate sizes and types of protection devices, feeder and motor. The selection should meet NEC requirements.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

l. Integral-horsepower starters
m. Single-phase magnetic starters
n. Motor selection
o. Service factor
p. Insulation classifications
q. Selecting split-phase motors
r. Selecting capacitor start motors
s. Selecting permanent split-capacitor motors
t. Selecting shaded pole motors

## TASK

SP-10 Performing single-phase motor maintenance and repair

## PERFORMANCE OBJECTIVE

Perform single-phase motor maintenance and repair.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. General maintenance procedures
b. Testing capacitors
c. Armature defects
d. Testing stator windings
e. Troubleshooting
f. Bearings
g. Test equipment

Provide Demonstration On:

a. Testing capacitors
b. Testing stator windings
c. Troubleshooting a SP motor

Provide Practical Application On:

a. Performing routine inspection and maintenance on a single-phase motor
b. Troubleshooting and repairing all problems

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Single-Phase Motors, Lesson Ten

Tools and Equipment:

a. Capacitor tester
b. VOM
c. Single-phase motors

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 5 |

## EVALUATION (SP-10)

Given a faulty single-phase motor and necessary tools and equipment, the student will perform general maintenance on the motor. The student will troubleshoot and repair the motor until it functions with 100% accuracy.

## TASK

PS-01 Identifying basic principles of polyphase motors

## PERFORMANCE OBJECTIVE

Identify basic principles of polyphase motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Induction motor construction
b. Squirrel-cage rotor
c. Rotating field
d. Polyphase relationships
e. Development of torque
f. Rotation change
g. Rotor speed and slip
h. Rotor frequency
i. Rotor resistance and reactance
j. Rotor current
k. Power factor of induction motors
l. Transformer principle of an induction motor
m. Induction motor torque
n. Current and voltage variation effects on torque

Provide Demonstration On:

a. Calculating synchronous field speed
b. Calculating rotor slip
c. Calculating rotor frequency

Provide Practical Application On:

a. Describing how a three-phase induction motor works
b. Calculating synchronous field speed
c. Calculating rotor slip
d. Calculating rotor frequency

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems Lesson One

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 8 |

## EVALUATION (PS-01)

Given specifications for a three-phase induction motor, the student will correctly describe the principle of operation for the motor and calculate with 100% accuraty its

1. Synchronous field speed
2. Rotor slip
3. Rotor frequency

## TASK

PS-02 Identifying induction motors, their operating principles and maintaining them

## PERFORMANCE OBJECTIVE

Identify induction motors, their operating principles and maintain them.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Squirrel-cage induction motor characteristics
b. Stator construction
c. Rotor construction
d. Field air gaps
c. Operating features
f. Torque
g. Stator windings maintenance
h. Wound-rotor induction motors
i. Wound-rotor construction
j. Brushes and sliprings
k. Operating characteristics of a wound rotor motor
l. Wound rotor maintenance
m. Speed regulation

(Continued on back)

Provide Demonstration On:

a. Inspecting and maintaining stator windings on an induction motor
b. Inspecting and maintaining a wound rotor
c. Maintaining squirrel cage motors

Provide Practical Application On:

Inspecting and maintaining
1. Stator windings in an induction motor
2. A motor wound rotor
3. A squirrel-cage motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems, Lesson Two

Tools and Equipment:

a. Induction motors
b. Wound rotor motors
c. Squirrel-cage motors
d. VOM
e. Tool kit

**LAB HOURS** 10

**CLASS HOURS** 5

## EVALUATION (PS-02)

Given an induction motor, wound-rotor motor, a squirrel-cage motor, a VOM and necessary tools, the student will correctly identify each type of motor and describe the operating principle of each. The student will inspect and maintain each type of motor for proper operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

n. Applications of wound-rotor motors
o. Squirrel-cage motor maintenance

## TASK

PS-03 Identifying and maintaining synchronous motors

## PERFORMANCE OBJECTIVE

Identify and maintain synchronous motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Synchronous motor characteristics
b. Operating principles
c. Synchronous motor fields
d. Starting characteristics
e. Pull-in torque
f. Effects of a slipping pole
g. Applications of synchronous motors
h. Effect on power factor
i. Power factor improvement
j. Brushless synchronous motors
k. Motor maintenance

Provide Demonstration On:

Maintaining a synchronous motor including airgap measurement, pole inspection, leads inspection and cleaning

Provide Practical Application On:

Maintaining a synchronous motor including airgap measurement, pole inspection, leads inspection and cleaning

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems, Lesson Three

Tools and Equipment:

a. Synchronous motors
b. Tool kit

**LAB HOURS** 10

**CLASS HOURS** 5

**EVALUATION** (PS-03)

Given a synchronous motor and all necessary tools and equipment, the student will identify the type of motor, its operating principles and maintain the motor.

## TASK

PS-04 Identifying, hooking up and operating multi-speed dual voltage motors

## PERFORMANCE OBJECTIVE

Identify, hook up and operate multi-speed dual voltage motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Multi-speed induction motor
    1. Multiple-winding motor
    2. Consequent-pole motor
b. Operating characteristics of consequent motors
c. Consequent-pole motor connections
d. Constant-horse power motor connections
e. Constant-torque motor connections
f. Variable-torque motor connections
g. Applications of multi-speed motors

(Continued on back)

Provide Demonstration On:

Hooking up and operating
1. Consequent pole motor
2. Constant horsepower motor
3. Constant-torque motor
4. Variable-torque motor
5. Dual voltage motors (Wye and Delta connected)

Provide Practical Application On:

Hooking up and operating
1. Consequent-pole motor
2. Constant-horsepower motor
3. Constant-torque motor
4. Variable-torque motor
5. Dual-voltage motors (Wye and Delta connected)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems, Lesson Four

Tools and Equipment:

a. Consequent-pole motor
b. Constant-horse power motor
c. Constant-torque motor
d. Variable-torque motor
e. Dual-voltage motors

LAB HOURS 10

CLASS HOURS 5

## EVALUATION (PS-04)

Given a selection of multi-speed, dual voltage motors, the student will identify the type of motor and correctly hook up and operate

1. Consequent-pole motor
2. Constant-horsepower motor
3. Constant-torque motor
4. Variable-torque motor
5. Dual-voltage motor (both Wye and Delta connected)

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Dual-voltage motor connections
    1. Why-connected
    2. Delta-connected

## TASK

PS-05 Maintaining polyphase motors

## PERFORMANCE OBJECTIVE

Maintain polyphase motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor maintenance requirements
b. Motor cleaning methods
c. Care of stator windings
d. Care of rotor windings
e. Motor airgap
f. Overloading
g. Bearing temperatures
h. Bearing lubrication

Provide Demonstration On:

a. Cleaning a motor
b. Maintaining motor
    1. Stator windings
    2. Rotor windings
    3. Airgap
c. Correcting overload
d. Lubricating motor bearings

Provide Practical Application On:

Maintaining a motor by
1. Cleaning
2. Checking stator windings
3. Checking rotor windings
4. Checking airgap
5. Correcting overload
6. Lubricating motor bearings

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems, Lesson Five

Tools and Equipment:

a. Polyphase motors
b. Brush
c. Hand bellows
d. Solvent
e. Varnish

(Continued on back)

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 5 |

## EVALUATION (PS-05)

Given a polyphase motor and all necessary tools and supplies, the student will maintain the motor by cleaning it properly, by checking the stator and rotor windings, the airgap and by correcting overload and properly lubricating the motor bearings.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

f. VOM
g. Grease and greasegun

## TASK

PS-06 Identifying basic principles of AC motor starting

## PERFORMANCE OBJECTIVE

Identify basic principles of AC motor starting.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor starters
   1. Reason for
   2. Operation of
b. Voltage limitations
c. Mechanical limitations
d. Full voltage starting
e. Across-the-line starting
f. Reduced voltage starter
g. Methods of reducing starting current
   1. Autotransformer
   2. Resistor
   3. Reactor
   4. Star-delta

(Continued on back)

Provide Practical Application On:

Identifying types of AC motors and starting devices and describing the operating principles of the starter

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems, Lesson Six

Tools and Equipment:

AC motors and starting devices

| | |
|---|---|
| LAB HOURS | 4 |
| CLASS HOURS | 8 |

## EVALUATION (PS-06)

Given an AC motor and starting system, the student will identify the method of motor starting and correctly describe its principle of operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Primary resistance starters
i. Secondary resistance starters
j. Reactor starters
k. Part winding starters
l. Wye-delta starting
m. Synchronous motor starting
n. Polyphase motor starter maintenance safety

## TASK

PS-07 Identifying polyphase motor controllers and their principles of operation

## PERFORMANCE OBJECTIVE

Identify types of polyphase motor controllers and describe their principles of operation.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Motor starters
b. Circuit protection
   1. Short circuit
   2. Low or no voltage
   3. No-voltage release
c. Multiple start-stop control
d. Across the line reversing starters
e. Plugging control
f. Jogging control
g. Back spin and surge control
h. Starting compensators
i. Magnetic conpensator starters

(Continued on back)

Provide Demonstration On:

Reading motor controlled circuit schematics

Provide Practical Application On:

a. Reading motor controller circuit schematic
b. Identifying the type of motor controller and describing its operation

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems Lesson Seven

Tools and Equipment:

Schematics for motor and roller circuits

**LAB HOURS** 4

**CLASS HOURS** 8

## EVALUATION (PS-07)

Given a schematic for a motor controller circuit, the student will accurately identify the type of motor controller and correctly describe its principle of operation.

### INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Primary resistor starters
k. Reactor starters
l. Wound-rotor motor starters
m. Reading motor controller circuit schematics

## TASK

PS-08 Identifying alternators and their applications

## PERFORMANCE OBJECTIVE

Identify alternators and their applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Alternator characteristics
b. Polyphase alternators
    1. Revolving armature type
    2. Revolving field type
c. Airgap
d. Slipsprings
e. Excitation
f. Rating of alternators
g. Alternator windings
h. Effect of current flow in the armature
i. Load characteristics and effects
j. Voltage regulation and voltage regulators

Provide Demonstration On:

a. Calculating alternator frequency
b. Calculating three-phase power output of an alternator

Provide Practical Application On:

a. Calculating alternator frequency for an assigned alternator with known speed and number of poles
b. Calculating three-phase power output for an alternator

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems Lesson Eight

Tools and Equipment:

Alternators

LAB HOURS 4
CLASS HOURS 8

## EVALUATION (PS-08)

Given an assigned alternator, the student will correctly identify the type of alternator and describe its operation. The student will calculate alternator frequency for a known speed and alternator power output with 100% accuracy.

## TASK

PS-09 Identifying and maintaining auxiliary generator systems

## PERFORMANCE OBJECTIVE

Identify and maintain auxiliary generator systems.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Auxiliary generator requirements
b. Voltage control equipment
c. Control equipment
d. Automatic transfer system
e. Time delay transfers
f. Safety switches
g. Engine protections
h. 400 Hertz generating systems
    1. General characteristics
    2. Voltage control
    3. Prime movers and output control
    4. 400 Hertz distribution
i. Maintenance procedures
    1. Cleaning

(Continued on back)

Provide Demonstration On:

Maintaining an auxiliary generator system including
1. Cleaning
2. Checking insulation
3. Checking electrical connections
4. Lubrication

Provide Practical Application On:

Maintaining an auxiliary generator system including
1. Cleaning
2. Checking insulation resistance
3. Checking electrical connections
4. Lubrication

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems, Lesson Nine

Tools and Equipment:

a. Cleaning supplies
b. Megohmeter
c. Lubricants
d. Auxiliary generator system

**LAB HOURS** 10
**CLASS HOURS** 5

## EVALUATION (PS-09)

Given an auxiliary generator system and necessary tools and supplies, the student will identify the type of system, its operating characteristics and maintain it by

1. Cleaning
2. Checking insulation resistance
3. Checking electrical connection
4. Lubrication

INSTRUCTIONAL ACTIVITIES

Provide Information On:

2. Insulation resistance
3. Electrical connections
4. Lubrication

# TASK

PS-10 Identifying and maintaining power distribution systems

# PERFORMANCE OBJECTIVE

Identify and maintain power distribution systems.

# INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Distribution voltages
b. Systems of 600 volts or less
    1. Heat losses
    2. System grounding
c. Benefits of system grounding
d. Overcurrent relay protection
e. Overcurrent relays with voltage control
f. Ground relays
g. Phase sequence or reverse phase relays
h. Circuit-opening devices

(Continued on back)

Provide Demonstration On:

a. Reading schematics for a power distribution system
b. Maintenance of a power distribution system

Provide Practical Application On:

a. Reading a schematic for a power distribution system and identifying components and their functions
b. Maintaining a power distribution system including

(Continued on back)

# INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Polyphase Systems, Lesson Ten

Tools and Equipment:

a. Power distribution system and related schematics
b. Tool kit
c. Meters

**LAB HOURS** 10

**CLASS HOURS** 10

## EVALUATION (PS-10)

Given a power distribution system, appropriate schematics tools and miters, the student will read the schematic and correctly identify all system components. The student will describe their function and maintain the system through
1. Visual inspection
2. Checking electrical connections
3. Performing tripping tests

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Types of protection
    1. Equipment protection
    2. Equipment circuit
j. Selective tripping
k. Cascade tripping
l. Network protection
m. Power distribution system schematics
n. Testing/maintenance of a distribution system
    1. Visual inspection
    2. Electrical connections
    3. Tripping tests

Provide Practical Application On:

1. Visual inspection
2. Checking electrical connections
3. Performing a tripping

## TASK

ACC-01 Identifying AC motor starter circuit and components

## PERFORMANCE OBJECTIVE

Identify types of AC motor starter circuits and components.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Selection of motor controls
   1. NEC requirements
   2. NEMA standards
   3. UL standards
b. Motor controllers
c. Controller enclosures
   1. Types
   2. NEMA classifications
d. Starters
e. Manual starters
f. Manual motor starting switches
g. Magnetic controls
h. Armature assemblies
   1. Clapper
   2. Vertical action
   3. Bell crank

(Continued on back)

Provide Demonstration On:

Reading AC motor starter circuit schematics

Provide Practical Application On:

a. Reading a schematic for an AC motor starter circuit
b. Identifying the components and their functions

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson One

Tools and Equipment:

Schematics for AC motor starter circuits

| | |
|---|---|
| LAB HOURS | 10 |
| CLASS HOURS | 10 |

## EVALUATION (ACC-01)

Given a schematic for an AC motor starter circuit, the student will correctly read the schematic, identify the type of circuit, their components and purpose in the function.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Magnetic circuits
j. Shading coil
k. Magnet coils
l. Effects of voltage variation
m. NEMA ratings of magnetic starters
n. AC hum
    1. Characteristic hum
    2. Causes of noisy or excessive hum
o. Magnetic starters-control circuits
    1. Components
    2. Schematics
p. Holding circuit interlocks
q. Electrical interlocks
r. Reversing starters
s. Combination starters

## TASK

ACC-02 Identifying and operating pushbutton control stations

## PERFORMANCE OBJECTIVE

Identify and operate pushbutton control stations.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Industrial switches
- b. Standard-duty pushbuttons
- c. Selector switches
- d. Wall boxes
- e. Single contact ratings
- f. Heavy-duty pushbuttons
- g. Heavy-duty contact ratings
- h. Types of pushbutton stations
- i. Accessories
- j. Oiltight pushbuttons
- k. Punch press pushbutton stations
- l. Pushbutton operators
    - 1. Selector switch operators
    - 2. Key operated selector switches

Provide Demonstration On:

Reading pushbutton control circuit schematic diagrams

Provide Practical Application On:

- a. Reading a schematic of a pushbutton control circuit
- b. Identifying the components and describing the operation of the system

## INSTRUCTIONAL MATERIALS

Textbooks:

- a. Training and Retaining, Inc., Basic Electricity/ Electronics
- b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson Two

Tools and Equipment:

Pushbutton control station circuit diagrams

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 10 |

## EVALUATION (ACC-02)

Given a circuit diagram for a pushbutton control station circuit, the student will correctly identify the type of circuit, name the components of the circuit and describe how the operation of the components relate to the total operation of the system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    3. Illuminated pushbuttons
m. Contact blocks
n. Indicating lights
o. Joystick operators
p. Circuit diagrams
q. Assembled pushbutton stations
r. Legend plates

## TASK

ACC-03 Identifying limit switches and their applications

## PERFORMANCE OBJECTIVE

Identify limit switches and their applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Precision snapaction limit switches
b. Precision switch elements
c. Precision snapswitch applications
d. Snapswitch contact arrangements
e. Snapswitch operating characteristics
f. Snapswitch actuation methods
g. Snapswitch enclosures
h. Limit switch applications
i. Limit switch contact arrangements
j. Limit switch actuators
k. Limit switch enclosures

(Continued on back)

Provide Demonstration On:

a. Mounting limit switches
b. Troubleshooting a faulty mercury switch and replacing it

Provide Practical Application On:

a. Mounting a limit switch
b. Troubleshoot a faulty mercury switch and replace it

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training, Systems, AC Control Equipment, Lesson Three

Tools and Equipment:

a. Limit switch and circuit
b. Mercury switch and circuit
c. Tool kit

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 10 |

## EVALUATION (ACC-03)

Given a limit switch, related circuit and necessary tools, the student will test the circuit, troubleshoot the switch, correctly determine the type of switch, choose and install an appropriate replacement and restore circuit to normal operation.

### INSTRUCTIONAL ACTIVITIES

Provide Information On:

l. Mounting limit switches
m. Cam design
n. Mercury tilt switches
o. Mercury switch construction
p. Mercury switch electrical characteristics
q. Mechanical characteristics
r. Mercury switch failure

## TASK

ACC-04 Identifying special control switches and their applications

## PERFORMANCE OBJECTIVE

Identify special control switches and their applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Reversing drum switches
b. Foot switches
c. Transfer switches
d. Plugging switches
e. Mechanical and magnetic plugging switches
f. Selecting a plugging switch
g. Pressure switches
h. Piston pressure switches
i. Diaphragm pressure switches
j. Bellows pressure switches
k. Temperature switches
l. Float switches
m. Electrical ratings

Provide Practical Application On:

Identifying types of switches and their applications

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/ Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson Four

Tools and Equipment:

Selection of special control switches

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 10 |

**EVALUATION** (ACC-04)

Given five different types of special control switches, the student will correctly identify each switch by type and describe its application.

## TASK

ACC-05 Identifying types of timers and counters and their applications

## PERFORMANCE OBJECTIVE

Identify types of timers and counters and their applications.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of timing devices
b. Interval or reset timers
c. Reset timer operation
d. Push-button-start interval timers
e. Time-delay relay
f. Pneumatic time delay relay
g. Repeat cycle timing
h. Percentage timers
i. Impulse counting
j. Electric counters
k. DC and AC operation of timers
l. Time totalizers
m. Revolution counters
n. Programming control
   1. Purpose
   2. Design
   3. Circuit diagram

Provide Demonstration On:

a. Designing a program control table and circuit
b. Choosing timers and counters

Provide Practical Application On:

Designing a program control circuit by developing a table and drawing in a circuit diagram

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson Five

Tools and Equipment:

a. Drawing paper
b. Pencils
c. Electrical symbol templates

**LAB HOURS** 20
**CLASS HOURS** 15

## EVALUATION (ACC-05)

Given requirements for a control circuit, the student will choose appropriate devices, draw a control circuit table and circuit diagram. The instructor will check the student's work for accuracy.

## TASK

ACC-06 Identifying and maintaining control relays

## PERFORMANCE OBJECTIVE

Identify and maintain control relays.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of relays
b. Relay types and characteristics
   1. ASA definition
   2. Duty classification
c. Relay contact operation
   1. Purpose of contacts
   2. Operation
   3. Switching abbreviations
d. Relay mountings
e. Relay enclosures
f. Terminals
g. Time delay relays
h. Voltage-sensing relays
i. Frequency-sensing relays
j. Phase-sequence sensing relays

(Continued on back)

Provide Demonstration On:

Troubleshooting relay failure

Provide Practical Application On:

a. Troubleshooting a faulty relay
b. Choosing a replacement
c. Installing a new relay

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson Six

Tools and Equipment:

a. Relays
b. Relay circuit
c. Tool kit

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 15 |

## EVALUATION (ACC-06)

Given a faulty control relay circuit and appropriate tools and supplies, the student will correctly identify the type(s) of relay(s), troubleshoot the fault in the circuit and choose and install appropriate replacement relays.

### INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Reed relay types
l. Operation of reed relays
m. NEMA industrial control relay classes
n. Industrial relay construction
o. Troubleshooting relay failure

## TASK

ACC-07 Identifying and maintaining types of industrial AC controls used in hazardous locations

## PERFORMANCE OBJECTIVE

Identify types of and maintain industrial AC controls used in hazardous locations.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Explosion proof apparatus
b. Dust-ignition-proof
c. NEC requirements
d. Class I atmospheric hazards
e. Class II atmospheric hazards
f. Class III atmospheric hazards
g. Sources of ignition
h. Combustion principles
i. Evaluation of hazardous area
j. Class I enclosures, division I and II conditions
k. Switch gear and industrial controls

(Continued on back)

Provide Practical Application On:

Performing basic maintenance checks on AC controls used in hazardous work areas

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson Seven

**LAB HOURS** 20
**CLASS HOURS** 15

## EVALUATION (ACC-07)

Given specifications for a hazardous area, the student will identify all AC controls used and show how they are made safe for use, correctly identify the NEC hazard class and describe all maintenance checks which should be made to assure the safety and proper operation of all devices.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

l. Motors and generators
m. Plugs and receptacles
n. Conduit for Class I locations
o. Seals for conduit system
p. Mineral insulated cable
q. Armored cable
r. Maintenance checks
    1. Electrical circuits
    2. Assembly/disassembly of enclosures
    3. Cover attachment screws
    4. Cleaning and lubrication
    5. Shaft and bearing surfaces
    6. Corrosive locations
    7. Portable equipment
    8. Overall safety
    9. Plug-in replacement units

## TASK

ACC-08 Identifying special motor control circuits and related schematics

## PERFORMANCE OBJECTIVE

Identify special motor control circuits and related schematics.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Synchronous motor control
b. Pushbutton synchronous motor control
c. Automatic synchronous motor control
d. Out-of-step relays
e. Automatic sequence accelerating relays
f. Automatic sequence decelerating relays
g. Manual auto transformer starters
h. Automatic transformer starters
i. Part-winding starting control
j. Primary resistance starting control

(Continued on back)

Provide Demonstration On:

Reading schematics for special motor control circuits

Provide Practical Application On:

Reading a schematic for a special motor control circuit, identifying the types of control and describing its operating principles

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson Eight

Tools and Equipment:

Schematics for special motor control circuit

**LAB HOURS** 15

**CLASS HOURS** 10

## EVALUATION (ACC-08)

Given a schematic for a special motor control circuit, the student will read the schematic, correctly identify the types of controls and describe the operating principles of the controls.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Multipoint resistance starting control
l. Wye-Delta starters
m. Reading schematics for special motor control circuits

## TASK

ACC-09 Identifying and installing motor control centers

## PERFORMANCE OBJECTIVE

Identify and install motor control centers.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of motor control centers
b. Construction of motor control centers
c. Motor control center bus
d. NEMA standards for motor control centers
e. Motor control center safety features
f. NEMA enclosures
g. NEMA wiring
h. Circuit protection
i. Motor control center installation

Provide Demonstration On:

Installing a motor control center

Provide Practical Application On:

Installing a motor control center

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson Nine

Tools and Equipment:

a. Motor control center components, enclosures and wiring
b. Tool kit

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 15 |

## EVALUATION (ACC-09)

Given specifications, all components, enclosures, wiring and necessary tools, the student will correctly install a motor control center which operates according to specifications.

## TASK

ACC-10 Wiring a control panel

## PERFORMANCE OBJECTIVE

Wire a control panel.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Control panel enclosures
b. Terminal blocks
c. Wire identification
d. Terminal connections of conductors
e. Wire connectors
f. Spring-type connectors
g. Pressure connectors
h. Tap connectors
i. Bolt pressure lugs
j. Connector markings
k. Wire dressing
l. Wiring duct

Provide Demonstration On:

Wiring a control panel

Provide Practical Application On:

Wiring a control panel

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

A/Vs:

Hobar, "Electric and Basic Controls," transparencies

Student Manuals:

Plant Engineering Training Systems, AC Control Equipment, Lesson Ten

Tools and Equipment:

a. Enclosures
b. Terminal blocks
c. Wire
d. Wire connectors
e. Wire dressing
f. Wire duct
g. Tool kit

**LAB HOURS** 20

**CLASS HOURS** 10

## EVALUATION (ACC-10)

Given specifications and necessary tools, supplies and equipment, the student will properly wire a control panel. The instructor will check the student's work.

## TASK

ET-01 Troubleshooting with electrical schematics

## PERFORMANCE OBJECTIVE

Troubleshoot an electrical circuit with a schematic.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Diagram identification
   1. J.I.C. standards
   2. Equipment diagrams
b. Symbols and device designation
c. Simple diagrams
d. Power circuit
e. Control circuit
f. Motor start circuit
g. Conductor identification
h. Numbering components
i. Locating relay contacts
j. Control panel layout and interconnection diagrams
k. Stock list
l. Sequence of operation
m. Related schematic information
   1. Limit switches

(Continued on back)

Provide Demonstration On:

a. Reading a schematic diagram
b. Troubleshooting an electrical circuit

Provide Practical Application On:

Using a schematic to troubleshoot an electrical circuit

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson One

Tools and Equipment:

a. Schematics
b. Electrical circuits
c. Tool kit

**LAB HOURS** 20

**CLASS HOURS** 10

## EVALUATION (ET-01)

Given a faulty electrical circuit and related schematics, the student will read the schematic, correctly trace the circuit, locate and repair the fault and restore the circuit to proper operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

2. Pressure switches
3. Float switches

## TASK

ET-02 Troubleshooting electrical circuits using building drawings

## PERFORMANCE OBJECTIVE

Use building drawings to troubleshoot electrical circuits.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Architectural drawings
b. Materials for construction
c. Installation drawings and diagrams
d. Riser diagrams
e. Substation drawings
f. One-line diagrams
g. One-line diagram details
h. Blueprint electrical symbols
i. Building-lighting diagrams
j. Power installation
k. Circuit tracing
l. Transformer circuit

Provide Demonstration On:

Tracing a circuit on a building drawing

Provide Practical Application On:

a. Troubleshooting a faulty electrical current
b. Using a building drawing

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson Two

Tools and Equipment:

a. Electrical circuits
b. Building drawings
c. Tool kit

| | |
|---|---|
| LAB HOURS | 20 |
| CLASS HOURS | 10 |

## EVALUATION (ET-02)

Given a faulty electrical circuit, related building drawings and necessary tools and equipment, the student will trace the circuit, locate and correct the fault and restore the circuit to normal operation.

## TASK

ET-03 Troubleshooting control circuits

## PERFORMANCE OBJECTIVE

Troubleshoot a faulty control circuit.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Control circuit functions
b. Control circuit malfunction
c. Conditions of protection
d. Maintained start/stop
e. Two-wire control
f. Three-wire control
g. Timed-sequence start
h. Troubleshooting a control circuit
i. Emergency stop circuit
j. Overload protection circuit
k. Control circuit voltages
l. Troubleshooting a stopped motor

Provide Demonstration On:

a. Troubleshooting a control circuit
b. Troubleshooting a stopped motor

Provide Practical Application On:

Troubleshooting a faulty control circuit and a stopped motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson Three

Tools and Equipment:

a. Control circuit
b. Schematics
c. Tool kit

| | |
|---|---|
| **LAB HOURS** | 15 |
| **CLASS HOURS** | 10 |

**EVALUATION** (ET-03)

Given a control circuit with a stopped motor and necessary tools, the student will troubleshoot the circuit and motor, correct the fault and restore the circuit to normal operation.

## TASK

ET-04 Troubleshooting combination starters

## PERFORMANCE OBJECTIVE

Troubleshoot a faulty combination starter.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Control circuit troubleshooting
b. Instruments for troubleshooting
c. Causes of breakdown
d. Troubleshooting problems
e. Safety
f. Troubleshooting control relays
g. Timing relay checks
h. Relay coil replacement

Provide Demonstration On:

a. Troubleshooting a control relay
b. Replacing a control relay

Provide Practical Application On:

Troubleshooting a combination starter circuit, testing control relays and replacing control relays

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson Four

Tools and Equipment:

a. Control relays
b. Combination starter circuit
c. Tool kit
d. VOM

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 10 |

**EVALUATION** (ET-04)

Given a faulty combination starter circuit, control relays, VOM and necessary tools, the student will troubleshoot the circuit, replace control relays as necessary and restore the circuit to normal operation.

## TASK

ET-05 Troubleshooting control devices

## PERFORMANCE OBJECTIVE

Troubleshoot faulty control devices.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Reversing controllers
b. Using a checking sequence chart
c. Closed transition auto transformer starter
d. Multi-speed motor starter controls

Provide Demonstration On:

Using a checking sequence chart to troubleshoot control devices

Provide Practical Application On:

Using a checking sequence chart to troubleshoot a faulty control circuit

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson Five

Tools and Equipment:

a. Checking sequence chart
b. Control circuit
c. VOM
d. Tool kit

**LAB HOURS** 15

**CLASS HOURS** 10

## EVALUATION (ET-05)

Given a faulty control circuit, VOM and tools, the student will troubleshoot the circuit, locate the fault and restore the circuit to normal operation.

## TASK

ET-06 Troubleshooting special controls

## PERFORMANCE OBJECTIVE

Troubleshoot special controls.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Troubleshooting selenium rectifiers
b. Troubleshooting three-phase rectifiers
c. Selenium rectifier life
d. Testing rectifier diodes
e. Checking three-phase rectifiers
f. Electric-pneumatic control circuits
g. Valve and relay comparison
h. Control system logic
i. Producing memory with feedback
j. Electronic static control principles
k. Logic function
l. Time delay element

Provide Demonstration On:

Troubleshooting a special control circuit

Provide Practical Application On:

a. Troubleshooting an assigned special control circuit
b. Identifying the type of control
c. Repairing the problem

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson Six

Tools and Equipment:

a. Special control circuits
b. VOM
c. Tool kit

| | |
|---|---|
| LAB HOURS | 15 |
| CLASS HOURS | 10 |

## EVALUATION (ET-06)

Given an assigned special control circuit which is faulty, the student will identify the type of control, troubleshoot the circuit, locate the fault, repair the problem and restore the circuit to normal operation.

## TASK

ET-07 Troubleshooting DC motors

## PERFORMANCE OBJECTIVE

Troubleshoot and repair DC motors.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. DC motor application
b. DC motor problems
c. Factors involving commutation
d. Commutator discoloration
e. Brush sparking
f. Open armature winding
g. Vibration
h. Electrical vibration
i. Mechanical vibration
j. Obvious motor failures
k. Special motor failure problems
    1. Improper brush grade
    2. Brush spacing
    3. Brush parallelism
    4. Commutation

(Continued on back)

Provide Demonstration On:

Troubleshooting a DC motor

Provide Practical Application On:

Troubleshooting and repairing a DC motor

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson Seven

Tools and Equipment:

a. Motors and DC circuits
b. VOM
c. Tool kit

**LAB HOURS** 15

**CLASS HOURS** 10

## EVALUATION (ET-07)

Given a defective DC motor, a VOM and necessary tools, the student will troubleshoot the motor, locate and correct the defect and restore the motor to normal operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

l. Stationary parts of a motor
m. Bearings
n. Starting and speed regulating controls
o. Drum controllers
p. Locating trouble
q. Fire and flood damage problems

## TASK

ET-08 Troubleshooting AC motors

## PERFORMANCE OBJECTIVE

Troubleshoot and repair an AC motor.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Causes of three-phase motor failures
b. Motor fails to operate or runs single-phase
c. Grounded stator windings
d. Shorted pole-phase groups
e. Reversed pole-phase groups
f. Short-circuited phases
g. Reversed phases
h. Open circuits in three-phase motor
i. Incorrect voltage connections
j. Determining markings of three-phase wye connections

(Continued on back)

Provide Demonstration On:

Troubleshooting an AC motor

Provide Practical Application On:

a. Troubleshooting an AC motor
b. Locating and repairing the fault

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson Eight

Tools and Equipment:

a. AC motors
b. VOM
c. Tool kit

LAB HOURS 15
CLASS HOURS 10

## EVALUATION (ET-08)

Given a defective AC motor, VOM and tools, the student will troubleshoot the motor, locate and repair the fault and restore the motor to normal operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Determining markings of three-phase delta connections
l. Troubleshooting split-phase motors
m. Grounded windings
n. Open circuits in split-phase motors
o. Short-circuited windings
p. Overloads
q. Noisy operation

## TASK

ET-09 Troubleshooting lighting systems

## PERFORMANCE OBJECTIVE

Troubleshoot and repair a lighting system.

## INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. General lighting system maintenance
b. Preventing overloads on lighting systems
c. Troubleshooting fluorescent lighting
d. Troubleshooting incadescent lighting
e. Troubleshooting mercury vapor lamps
f. Troubleshooting lamps
g. Troubleshooting remote control low-voltage switching
h. Remote control components
i. Remote control relay switching system

Provide Demonstration On:

Troubleshooting a defective lighting system

Provide Practical Application On:

Troubleshooting a defective lighting system

(Continued on back)

## INSTRUCTIONAL MATERIALS

Textbooks:

a. Training and Retraining, Inc., Basic Electricity/Electronics
b. Loper, Introduction to Electricity and Electronics

Student Manuals:

Plant Engineering Training Systems, Electrical Troubleshooting, Lesson Nine

Tools and Equipment:

a. Lighting system
b. Tool kit

**LAB HOURS** 20

**CLASS HOURS** 15

## **EVALUATION** (ET-09)

Given a defective lighting system, the student will troubleshoot the system, locate the fault, repair it and return the system to normal operation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- j. Selective switching using rectifiers
- k. Important considerations and restrictions
    - 1. Manufacturer's specifications
    - 2. Transformer load
    - 3. Relays connected in parallel
- l. NEC requirements
- m. Reaching lighting equipment

# SECTION IV

## CURRICULUM STRUCTURE, EXIT POINTS & COURSE OUTLINE

# SECTION IV

## Section IV Content List

Introduction to the Curriculum Structure
Curriculum Structure
  Group
  Individualized
Introduction to Electrical Technology Exit Points
Electrical Technology Exit Points
  Group
  Individualized
Introduction to the Course Outline
Course Outline

Section III presented a sample organizational model for sequencing the instruction of program tasks. Based on that model, Section IV provides suggested methods of structuring the entire Electrical Technology curriculum.

## ELECTRICAL TECHNOLOGY SUGGESTED CURRICULUM STRUCTURE*

| Course | Class Hours | Lab Hours | Total Hours |
|---|---|---|---|
| Quarter I | | | |
| INTRODUCTION TO ELECTRICITY/ ELECTRONICS | 55 | 36 | 91 |
| ELECTROCHEMICAL ACTION AND DC | 26 | 52 | 78 |
| ALTERNATING CURRENT | 43 | 70 | 113 |
| | 124 | 158 | 282 |
| Quarter II | | | |
| MEASURING INSTRUMENTS | 100 | 175 | 275 |
| | 100 | 175 | 275 |
| Quarter III | | | |
| PROTECTIVE DEVICES | 125 | 130 | 255 |
| | 125 | 130 | 255 |
| Quarter IV | | | |
| EQUIPMENT AND CONTROLS | 105 | 140 | 245 |
| | 105 | 140 | 245 |
| Quarter V | | | |
| SINGLE PHASE MOTORS | 71 | 83 | 154 |
| POLYPHASE SYSTEMS | 67 | 76 | 143 |
| | 138 | 159 | 297 |
| Quarter VI | | | |
| AC CONTROL EQUIPMENT | 120 | 170 | 290 |
| | 120 | 170 | 290 |
| Quarter VII | | | |
| ELECTRICAL TROUBLESHOOTING | 95 | 150 | 245 |
| | 95 | 150 | 245 |
| Total Program Hours | 807 | 1082 | 1889 |

*This curriculum structure is designed to be used for group instruction.

# ELECTRICAL TECHNOLOGY SUGGESTED CURRICULUM STRUCTURE*

ORIENTATION:
- School Policies and Procedures
- Program Orientation and Safety
- Operation of Audiovisual Equipment
- Using the Learning Resource Center

BASIC ELECTRICITY:
- Introduction to Electricity/Electronics
- Electrochemical Action and DC
- Alternating Current
- Measuring Instruments
- Protective Devices

MOTORS AND CONTROLS:
- DC Equipment and Controls
- Single Phase Motors
- Polyphase Systems
- AC Control Equipment
- Electrical Troubleshooting

---

*This curriculum structure is designed to be used for individualized instruction.

# INTRODUCTION TO ELECTRICAL TECHNOLOGY EXIT POINTS

The following diagrams illustrate points in the Electrical Technology program where a student should have acquired competencies necessary for entry level employment.

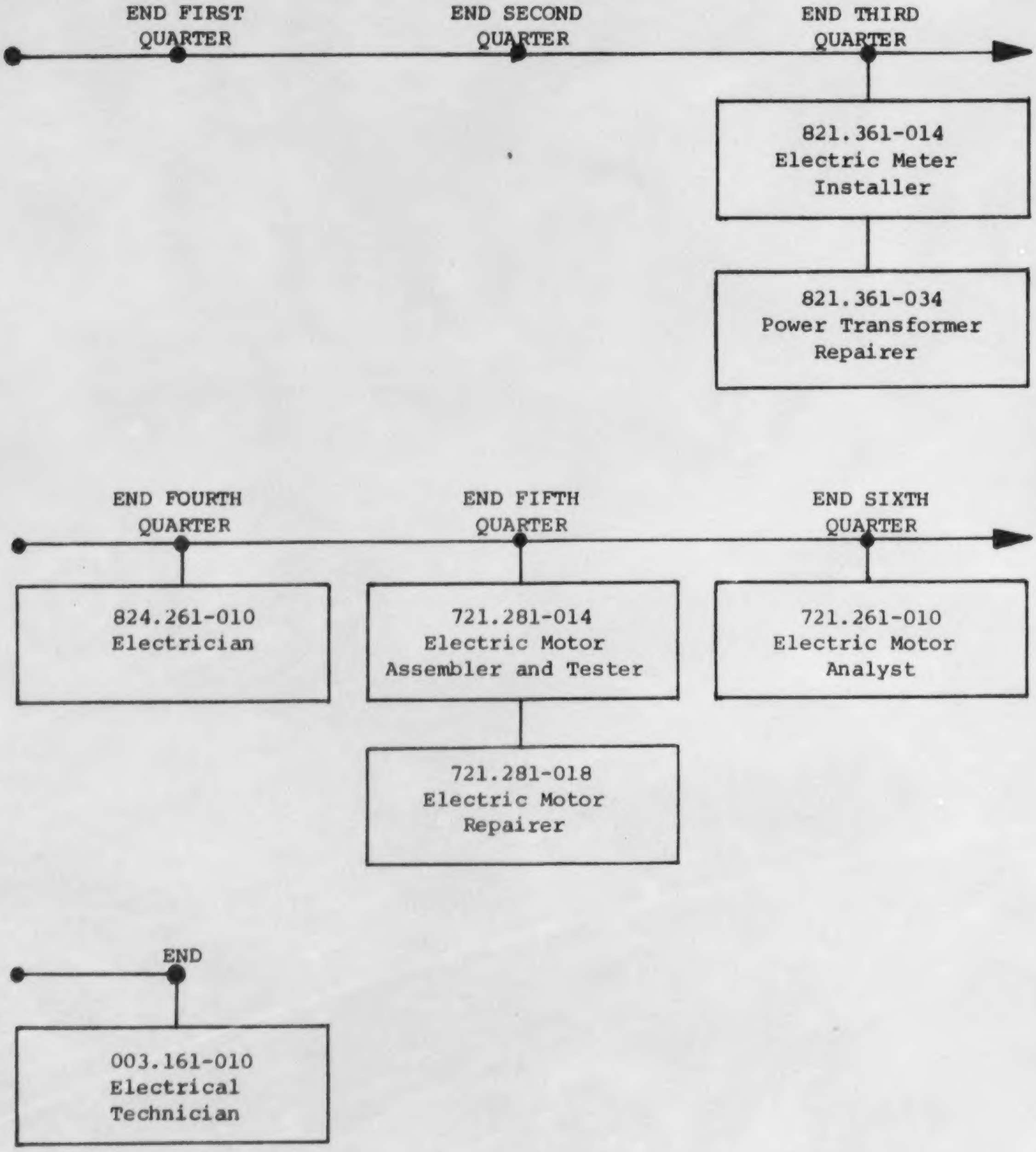
Both the group and individualized exit point diagrams sequence the Electrical Technology job classifications from least to most difficult. The group exit point diagram illustrates a lock-step process in which students proceed through an entire program at the same pace and exit at approximately the same point in time.

The individualized exit point diagram illustrates a self-paced progression through the Electrical Technology program. This approach permits a student to complete any one or all tasks necessary for entry level employment.

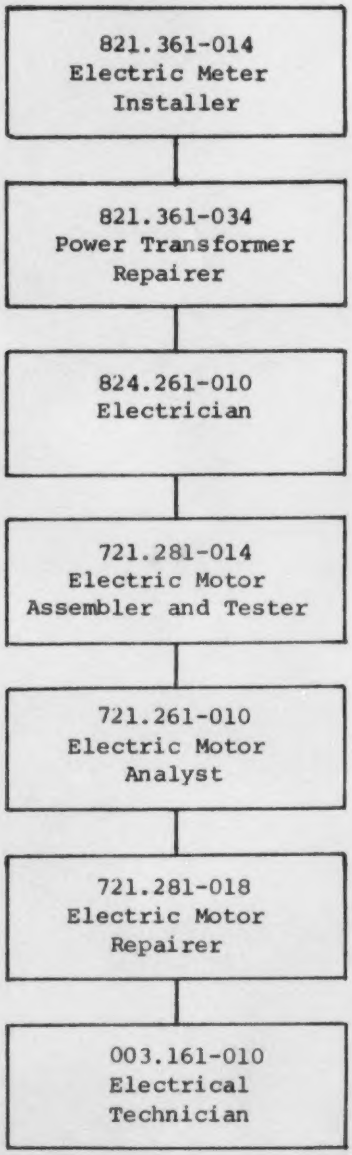
The major difference between the group and individualized approach is the number of tasks a student must master. For example, in the individualized approach, a student desiring employment as an electrician needs to complete only those tasks identified for that job. However, in the group approach, a student must master the tasks in the previous DOT classifications leading to that particular job title.

Both diagrams are based on the preceeding suggested curriculum structures.

# ELECTRICAL TECHNOLOGY
(GROUP INSTRUCTION)


END FIRST QUARTER
END SECOND QUARTER
END THIRD QUARTER
821.361-014 Electric Meter Installer
821.361-034 Power Transformer Repairer
END FOURTH QUARTER
END FIFTH QUARTER
END SIXTH QUARTER
824.261-010 Electrician
721.281-014 Electric Motor Assembler and Tester
721.261-010 Electric Motor Analyst
721.281-018 Electric Motor Repairer
END
003.161-010 Electrical Technician

## ELECTRICAL TECHNOLOGY
## (INDIVIDUALIZED INSTRUCTION)


821.361-014
Electric Meter Installer
821.361-034
Power Transformer Repairer
824.261-010
Electrician
721.281-014
Electric Motor Assembler and Tester
721.261-010
Electric Motor Analyst
721.281-018
Electric Motor Repairer
003.161-010
Electrical Technician

# INTRODUCTION TO THE COURSE OUTLINE

A course outline suggests a method of sequencing tasks for instruction. In the following outline, the unit guide tasks are ordered according to duty areas. The tasks are then arranged from general to specific knowledge and applications. The instructor is not restricted to using this specific outline, but may adapt it to meet his or her teaching needs.

The following course outline is designed for group instruction, however, it may be adapted for individualized instruction by eliminating the time sequencing for tasks.

# ELECTRICAL TECHNOLOGY SUGGESTED COURSE OUTLINE

## QUARTER I

| Task | Title | Class Hours | Lab Hours |
|---|---|---|---|
| | DUTY I: INTRODUCTION TO ELECTRICITY/ ELECTRONICS | | |
| IE-01 | Identifying sources of electrical energy | 5 | 1 |
| IE-02 | Identifying static electricity | 5 | 1 |
| IE-03 | Identifying principles of electric current and voltage | 5 | 5 |
| IE-04 | Identifying principles of electromagnetic induction | 5 | 5 |
| IE-05 | Identifying principles of current flow and resistance | 5 | 5 |
| IE-06 | Identifying resistors and capacitors | 10 | 5 |
| IE-07 | Identifying and using hand tools | 5 | 2 |
| IE-08 | Identifying conductors and fittings | 5 | 2 |
| IE-09 | Identifying DC circuits | 5 | 5 |
| IE-10 | Identifying AC circuits | 5 | 5 |
| | | 55 | 36 |
| | DUTY II: ELECTROCHEMICAL ACTION AND DC | | |
| EC-01 | Identifying basic principles of electrochemical action | 1 | 5 |
| EC-02 | Identifying types of batteries | 1 | 5 |
| EC-03 | Identifying the electrochemical action of batteries | 5 | 5 |
| EC-04 | Performing battery maintenance | 5 | 5 |
| EC-05 | Charging batteries and maintaining battery records | 5 | 5 |
| EC-06 | Identifying fundamental DC circuits | 2 | 10 |
| EC-07 | Identifying properties of DC circuits | 1 | 5 |
| EC-08 | Identifying properties of DC parallel circuits | 2 | 5 |
| EC-09 | Identifying series parallel circuits | 3 | 2 |
| EC-10 | Identifying practical applications of DC circuits | 1 | 5 |
| | | 26 | 52 |
| | DUTY III: ALTERNATING CURRENT | | |
| AC-01 | Identifying characteristics of AC circuits | 5 | 5 |
| AC-02 | Identifying sine wave fundamentals | 5 | 10 |
| AC-03 | Calculating induction reactance | 5 | 10 |
| AC-04 | Calculating capacitive reactance | 5 | 10 |
| AC-05 | Identifying and calculating impedance | 5 | 10 |
| AC-06 | Identifying practical applications of alternating current | 5 | 5 |
| AC-07 | Identifying polyphase circuits and calculating phase and line voltage | 5 | 5 |

| Task | Title | Class Hours | Lab Hours |
|---|---|---|---|
| AC-08 | Identifying principles to transformers | 1 | 5 |
| AC-09 | Identifying transformer connections, applications and installation | 2 | 5 |
| AC-10 | Maintaining transformers | 5 | 5 |
|  |  | 43 | 70 |

Total Quarter I Class and Lab Hours 124 158
Related Instruction Hours 30
Total Quarter I Instructional Hours 312

## QUARTER II

| Task | Title | Class Hours | Lab Hours |
|---|---|---|---|
| | DUTY IV: MEASURING INSTRUMENTS | | |
| MI-01 | Identifying operating principles of electric meters | 5 | 20 |
| MI-02 | Identifying and using DC instruments | 5 | 25 |
| MI-03 | Measuring resistance and insulation | 10 | 10 |
| MI-04 | Identifying operating principles of AC meters | 5 | 25 |
| MI-05 | Selecting a meter and making an AC measurement | 15 | 10 |
| MI-06 | Identifying and using power measuring instruments | 10 | 10 |
| MI-07 | Identifying and using special measuring instruments | 15 | 15 |
| MI-08 | Identifying and using indicating instruments | 10 | 15 |
| MI-09 | Identifying recording instruments and procedures for instrument care and maintenance | 15 | 20 |
| MI-10 | Identifying and using electronic measuring instruments | 10 | 25 |
| | | 100 | 175 |

Total Quarter II Class and Lab Hours 100 175
Related Instruction Hours 37
Total Quarter II Instructional Hours 312

## QUARTER III

| Task | Title | Class Hours | Lab Hours |
|---|---|---|---|
| | DUTY V: PROTECTIVE DEVICES | | |
| PD-01 | Identifying and maintaining protective devices | 10 | 20 |
| PD-02 | Identifying and maintaining circuit breakers | 15 | 20 |
| PD-03 | Identifying and maintaining overload relays | 10 | 20 |
| PD-04 | Identifying applications of protective devices | 10 | 10 |
| PD-05 | Grounding AC circuits | 10 | 10 |
| PD-06 | Identifying applications of the National Electrical Code | 30 | 0 |
| PD-07 | Making basic electrical calculations | 10 | 20 |
| PD-08 | Identifying wireway systems | 10 | 10 |
| PD-09 | Identifying methods of industrial illumination | 10 | 10 |
| PD-10 | Identifying procedures for electrical safety and maintenance | 10 | 10 |
| | | 125 | 130 |

| | | | |
|---|---|---|---|
| Total Quarter III Class and Lab Hours | 125 | | 130 |
| Related Instruction Hours | | 57 | |
| Total Quarter III Instructional Hours | | 312 | |

## QUARTER IV

| Task | Title | Class Hours | Lab Hours |
|---|---|---|---|
| | DUTY VI: EQUIPMENT AND CONTROLS | | |
| DC-01 | Identifying sources of DC power in industry | 5 | 15 |
| DC-02 | Identifying principles and applications of electromagnetism in DC circuits | 5 | 15 |
| DC-03 | Identifying applications of DC generators | 15 | 15 |
| DC-04 | Identifying principles and applications of DC motors | 10 | 15 |
| DC-05 | Identifying types of DC armatures and maintaining them | 10 | 20 |
| DC-06 | Identifying types and operating principles of DC relays | 10 | 15 |
| DC-07 | Identifying DC controllers and their operating principles | 15 | 5 |
| DC-08 | Identifying and maintaining DC power supplies | 15 | 10 |
| DC-09 | Identifying principles and applications of silicon controlled rectifiers | 10 | 10 |
| DC-10 | Performing basic DC circuit maintenance | 10 | 20 |
| | | 105 | 140 |

| | | | |
|---|---|---|---|
| Total Quarter IV Class and Lab Hours | 105 | | 140 |
| Related Instruction Hours | | 67 | |
| Total Quarter IV Instructional Hours | | 312 | |

## QUARTER V

| Task | Title | Class Hours | Lab Hours |
|---|---|---|---|
| | DUTY VII: SINGLE-PHASE MOTORS | | |
| SP-01 | Identifying basic operating principles of single-phase motors | 8 | 4 |
| SP-02 | Identifying and maintaining split-phase motors | 5 | 10 |
| SP-03 | Identifying and maintaining capacitor motors | 5 | 10 |
| SP-04 | Identifying and maintaining repulsion motors | 5 | 10 |
| SP-05 | Identifying and maintaining universal motors | 5 | 10 |
| SP-06 | Identifying special purpose single-phase motors | 8 | 4 |
| SP-07 | Identifying synchro-systems and applications | 10 | 10 |
| SP-08 | Identifying servomechanisms and their principles of operation | 10 | 10 |
| SP-09 | Identifying starting and protection devices for single-phase motor | 10 | 5 |
| SP-10 | Performing single-phase motor maintenance and repairs | 5 | 10 |
| | | 71 | 83 |
| | DUTY VIII: POLYPHASE SYSTEMS | | |
| PS-01 | Identifying basic principles of polyphase motors | 8 | 4 |
| PS-02 | Identifying induction motors and their operating principles and maintaining them | 5 | 10 |
| PS-03 | Identifying and maintaining synchronous motor | 5 | 10 |
| PS-04 | Identifying, hooking up and operating multi-speed dual voltage motors | 5 | 10 |
| PS-05 | Maintaining polyphase motors | 5 | 10 |
| PS-06 | Identifying basic principles of AC motor starting | 8 | 4 |
| PS-07 | Identifying polyphase motor controllers and their principles of operation | 8 | 4 |
| PS-08 | Identifying alternators and their applications | 8 | 4 |
| PS-09 | Identifying and maintaining auxiliary generator systems | 5 | 10 |
| PS-10 | Identifying and maintaining power distribution systems | 10 | 10 |
| | | 67 | 76 |
| | Total Quarter V Class and Lab Hours | 138 | 159 |
| | Related Instruction Hours | 15 | |
| | Total Quarter V Instructional Hours | 312 | |

## QUARTER VI

| Task | Title | Class Hours | Lab Hours |
|---|---|---|---|
| | DUTY IX: AC CONTROL EQUIPMENT | | |
| ACC-01 | Identifying AC motor starter circuit and components | 10 | 10 |
| ACC-02 | Identifying and operating pushbutton control stations | 10 | 15 |
| ACC-03 | Identifying limit switches and their applications | 10 | 15 |
| ACC-04 | Identifying special control switches and their applications | 10 | 15 |
| ACC-05 | Identifying types of timers and counters and their applications | 15 | 20 |
| ACC-06 | Identifying and maintaining control relays | 15 | 20 |
| ACC-07 | Identifying and maintaining types of industrial AC controls used in hazardous locations | 15 | 20 |
| ACC-08 | Identifying special motor control circuits and related schematics | 10 | 15 |
| ACC-09 | Identifying and installing motor control centers | 15 | 20 |
| ACC-10 | Wiring a control panel | 10 | 20 |
| | | 120 | 170 |

Total Quarter VI Class and Lab Hours 120 170
Related Instruction Hours 22
Total Quarter VI Instructional Hours 312

## QUARTER VII

| Task | Title | Class Hours | Lab Hours |
|---|---|---|---|
| | DUTY X: ELECTRICAL TROUBLESHOOTING | | |
| ET-01 | Troubleshooting with electrical schematics | 10 | 20 |
| ET-02 | Troubleshooting electrical circuits using building drawings | 10 | 20 |
| ET-03 | Troubleshooting control circuits | 10 | 15 |
| ET-04 | Troubleshooting combination starters | 10 | 15 |
| ET-05 | Troubleshooting control devices | 10 | 15 |
| ET-06 | Troubleshooting special controls | 10 | 15 |
| ET-07 | Troubleshooting DC motors | 10 | 15 |
| ET-08 | Troubleshooting AC motors | 10 | 15 |
| ET-09 | Troubleshooting lighting systems | 15 | 20 |
| | | 95 | 150 |
| | Total Quarter VII Class and Lab Hours | 95 | 150 |
| | Related Instruction Hours | 67 | |
| | Total Quarter VII Instructional Hours | 312 | |
| | Total Program Hours | 2184 | |

# SECTION V

## RECORDS

# SECTION V

## Section V Content List

Individualized Competency Record
Group Progress Chart

Section V presents suggested ways of recording and documenting the progress of students through the curriculum. The recommended procedures include options for both individual and group records. The very important function of communicating the student's qualifications to potential employers is handled clearly and efficiently by the use of the Certificate of Competency, which is also described in this section.

# RECORDS MANAGEMENT

This guide provides a series of easy to use documents that will aid the instructor in recordkeeping and that will be beneficial to the student in entering the work force.

In addition to providing the instructor with an "at a glance" assessment of individual and/or group progress, a Certificate of Competency, which can be used by students seeking employment, is included.

The group progress chart reflects individual task completion of all students. Due to confidentiality of records, grades must not be recorded on the chart. A notation indicating task completion (i.e., x or check) should be used.

# INSTRUCTIONS

## Instructions

Competency Checklist

1) Enter the student's name.
2) Enter the date and instructor's initials as each unit of instruction is completed.

The Competency Checklist automatically indicates when all the requirements for each DOT exit point or job title have been completed by the student. At each point on the certificate where an asterisk appears, the student is eligible to receive a Certificate of Competency.

Certificate of Competency

A Certificate of Competency is to be issued for each job title for which a student is qualified.

1) Enter the student's name.
2) Enter the school's name
3) Sign and date the form.

A Certificate of Competency may be issued at the time a student qualifies for it, or all certificates for which a student qualifies may be issued to the student when he/she completes or leaves the program.

Group Progress Chart

1) Enter all program tasks across top of matrix.
2) Enter the students' names down the left hand side of matrix.
3) As each student completes a task, a notation should be made in the square which corresponds with the task and the student's name.

# COMPETENCY CHECKLIST

**PROGRAM:** ELECTRICAL TECHNOLOGY

**STUDENT NAME:** ______________________________

EXIT POINTS

| TASK NO. | UNIT COMPETENCIES | DATE | IN'T. | JOB TITLE: Electric Meter Installer | Power Transformer Repairer | Electric Motor Analyst | Electric Motor Assembler and Tester | Electric Motor Repairer | Electrician | Electrical Technician |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DOT NO.: 821.361-014 | 821.361-034 | 721.261-010 | 721.281-014 | 721.281-018 | 824.261-010 | 003.161-010 |
| | Introduction to Electricity/Electronics | | | | | | | | | |
| IE-01 | Identifying sources of electrical energy | | | X | X | X | X | X | X | X |
| IE-02 | Identifying static electricity | | | X | X | X | X | X | X | X |
| IE-03 | Identifying principles of electric current | | | X | X | X | X | X | X | X |
| IE-04 | Identifying principles of electromagnetic induction | | | X | X | X | X | X | X | X |
| IE-05 | Identifying principles of current flow and resistance | | | X | X | X | X | X | X | X |
| IE-06 | Identifying resistors and capacitors | | | X | X | X | X | X | X | X |
| IE-07 | Identifying and using hand tools | | | X | X | X | X | X | X | X |
| IE-08 | Identifying conductors and fittings | | | X | X | X | X | X | X | X |
| IE-09 | Identifying DC circuits | | | X | X | X | X | X | X | X |
| IE-10 | Identifying AC circuits | | | X | X | X | X | X | X | X |
| | Electrochemical Action and DC | | | | | | | | | |
| EC-01 | Identifying basic principles of electrochemical action | | | | | X | | | X | X |
| EC-02 | Identifying types of batteries | | | | | X | | | X | X |
| EC-03 | Identifying the electrochemical action of batteries | | | | | X | | | X | X |
| EC-04 | Performing battery maintenance | | | | | X | | | X | X |
| EC-05 | Charging batteries and maintaining battery records | | | | | X | | | X | X |
| EC-06 | Identifying fundamental DC circuits | | | | | X | | | X | X |
| EC-07 | Identifying properties of DC circuits | | | | | X | | | X | X |
| EC-08 | Identifying properties of DC parallel circuits | | | | | X | | | X | X |
| EC-09 | Identifying series parallel circuits | | | | | X | | | X | X |
| EC-10 | Identifying practical application of DC circuits | | | | | X | | | X | X |
| | Alternating Current | | | | | | | | | |
| AC-01 | Identifying characteristics of AC circuits | | | X | X | X | | | X | X |
| AC-02 | Identifying sine wave fundamentals | | | X | X | X | | | X | X |
| AC-03 | Calculating induction reactance | | | X | X | X | | | X | X |
| AC-04 | Calculating capacitive reactance | | | X | X | X | | | X | X |
| AC-05 | Identifying and calculating impedance | | | X | X | X | | | X | X |
| AC-06 | Identifying practical application of alternating current | | | X | X | X | | | X | X |
| AC-07 | Identifying polyphase circuits and calculating phase and line voltage | | | | X | X | | | X | X |
| AC-08 | Identifying principles of transformers | | | | X | | | | X | X |
| AC-09 | Identifying transformer connections and installation | | | | X | | | | X | X |
| AC-10 | Maintaining transformers | | | | X | | | | X | X |
| | Measuring Instruments | | | | | | | | | |
| MI-01 | Identifying operating principles of electrical meters | | | X | X | X | X | X | X | X |
| MI-02 | Identifying and using DC instruments | | | | | X | X | X | X | X |
| MI-03 | Measuring resistance and insulation | | | X | X | X | X | X | X | X |
| MI-04 | Identifying operating principles of AC meters | | | X | X | X | X | X | X | X |
| MI-05 | Selecting a meter and making an AC measurement | | | X | X | X | X | X | X | X |
| MI-06 | Identifying and using power measuring instruments | | | X | X | X | X | X | X | X |
| MI-07 | Identifying and using special measuring instruments | | | X | X | X | X | X | X | X |
| MI-08 | Identifying and using indicating instruments | | | X | X | X | X | X | X | X |
| MI-09 | Identifying recording instruments and procedures for instrument care and maintenance | | | | | X | X | X | X | X |
| MI-10 | Identifying and using electronic measuring instruments | | | | | X | X | X | X | X |
| | Protective Devices | | | | | | | | | |
| PD-01 | Identifying and maintaining protective devices | | | X | X | X | X | X | X | X |
| PD-02 | Identifying and maintaining circuit breakers | | | | X | X | X | X | X | X |
| PD-03 | Identifying and maintaining overload relays | | | | X | X | X | X | X | X |
| PD-04 | Identifying applications of protective devices | | | | X | X | X | X | X | X |
| PD-05 | Grounding AC circuits | | | X | X | X | X | X | X | X |

# COMPETENCY CHECKLIST

EXIT POINTS

**PROGRAM:** ELECTRICAL TECHNOLOGY

**STUDENT NAME:**______________________________________

JOB TITLE
DOT NO.

| TASK NO. | UNIT COMPETENCIES | DATE | IN'T. | Electric Meter Installer 821.361-014 | Power Transformer Repairer 821.361-034 | Electric Motor Analyst 721.261-010 | Electric Motor Assembler and Tester 721.281-014 | Electric Motor Repairer 721.281-018 | Electrician 824.261-010 | Electrical Technician 003.161-010 |
|---|---|---|---|---|---|---|---|---|---|---|
| PD-06 | Identifying applications of the National Electrical Code | | | X | X | X | X | X | X | X |
| PD-07 | Making basic electrical calculations | | | X | X | X | | X | X | X |
| PD-08 | Identifying wireway systems | | | | X | X | | | X | X |
| PD-09 | Identifying methods of industrial illumination | | | | | | | | X | X |
| PD-10 | Identifying procedures for electrical safety and maintenance | | | *X | X | X | X | X | *X | X |
| | DC Equipment and Controls | | | | | | | | | |
| DC-01 | Identifying sources of DC power for industry | | | | | X | | | | X |
| DC-02 | Identifying principles and applications of electromagnetism in DC circuits | | | | | X | | | | X |
| DC-03 | Identifying applications of DC generators | | | | | X | | | | X |
| DC-04 | Identifying principles and applications of DC motors | | | | | X | | | | X |
| DC-05 | Identifying types of and maintaining DC armatures | | | | | X | | | | X |
| DC-06 | Identifying types and operating principles of DC relays | | | | | X | | | | X |
| DC-07 | Identifying DC controllers and their operating principles | | | | | X | | | | X |
| DC-08 | Identifying and maintaining DC power supplies | | | | | X | | | | X |
| DC-09 | Identifying principles and applications of silicon controlled rectifiers | | | | | X | | | | X |
| DC-10 | Performing basic DC circuit maintenance | | | | | X | | | | X |
| | Single Phase Motors | | | | | | | | | |
| SP-01 | Identifying basic operating principles of single phase motors | | | | | X | X | X | | X |
| SP-02 | Identifying and maintaining split phase motors | | | | | X | X | X | | X |
| SP-03 | Identifying and maintaining capacitor motors | | | | | X | X | X | | X |
| SP-04 | Identifying and maintaining repulsion motors | | | | | X | X | X | | X |
| SP-05 | Identifying and maintaining universal motors | | | | | X | X | X | | X |
| SP-06 | Identifying special purpose single phase motors | | | | | X | X | X | | X |
| SP-07 | Identifying synchro-systems and applications | | | | | X | X | X | | X |
| SP-08 | Identifying servomechanisms and their principles of operation | | | | | X | X | X | | X |
| SP-09 | Identifying starting and protection devices for single phase motor | | | | | X | X | X | | X |
| SP-10 | Performing single phase motor maintenance and repairs | | | | | X | X | X | | X |
| | Polyphase Systems | | | | | | | | | |
| PS-01 | Identifying basic principles of polyphase motors | | | | | X | X | X | | X |
| PS-02 | Identifying induction motors and their operating principles and maintaining them | | | | | X | X | X | | X |
| PS-03 | Identifying and maintaining synchronous motor | | | | | X | X | X | | X |
| PS-04 | Identifying, hooking up and operating multi-speed dual voltage | | | | | X | X | X | | X |
| PS-05 | Maintaining polyphase motors | | | | | X | X | X | | X |
| PS-06 | Identifying basic principles of AC motor starting | | | | | X | X | X | | X |
| PS-07 | Identifying polyphase motor controllers and their operating principles | | | | | X | X | X | | X |
| PS-08 | Identifying alternators and their operating principles | | | | | X | X | X | | X |
| PS-09 | Identifying and maintaining auxiliary generator systems | | | | | X | X | X | | X |
| PS-10 | Identifying and maintaining power distribution systems | | | | | X | *X | X | | X |
| | AC Control Equipment | | | | | | | | | |
| ACC-01 | Identifying AC motor starter circuit components | | | | | X | | X | | X |
| ACC-02 | Identifying and operating pushbutton control stations | | | | | X | | X | | X |
| ACC-03 | Identifying limit switches and their applications | | | | | X | | X | | X |
| ACC-04 | Identifying special control switches and their applications | | | | | X | | X | | X |
| ACC-05 | Identifying types of timers and counters and their applications | | | | | X | | X | | X |
| ACC-06 | Identifying and maintaining control relays | | | | | X | | X | | X |
| ACC-07 | Identifying and maintaining types of industrial AC controls used in hazardous locations | | | | | X | | X | | X |
| ACC-08 | Identifying special motor control circuits and related schematics | | | | | X | | X | | X |

## COMPETENCY CHECKLIST

**PROGRAM:** ELECTRICAL TECHNOLOGY

**STUDENT NAME:**________________________________________

EXIT POINTS

| TASK NO. | UNIT COMPETENCIES | DATE | IN'T. | JOB TITLE<br>Electric Meter Installer | Power Transformer Repairer | Electric Motor Analyst | Electric Motor Assembler and Tester | Electric Motor Repairer | Electrician | Electrical Technician |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DOT NO.<br>821.361-014 | 821.361-034 | 721.261-010 | 721.281-014 | 721.281-018 | 824.261-010 | 003.161-010 |
| ACC-09 | Identifying and installing motor control centers | | | | | X | | X | | X |
| ACC-10 | Wiring a control panel | | | | | X | | X | | X |
| | Electrical Troubleshooting | | | | | | | | | |
| ET-01 | Troubleshooting with electrical schematics | | | | | X | | X | | X |
| ET-02 | Troubleshooting electrical circuits using building drawings | | | | | *X | | | | X |
| ET-03 | Troubleshooting control circuits | | | | X | | | X | | X |
| ET-04 | Troubleshooting combination starters | | | | X | | | X | | X |
| ET-05 | Troubleshooting control devices | | | | X | | | X | | X |
| ET-06 | Troubleshooting special controls | | | | X | | | | | X |
| ET-07 | Troubleshooting DC motors | | | | X | | | X | | X |
| ET-08 | Troubleshooting AC motors | | | | *X | | | *X | | X |
| ET-09 | Troubleshooting lighting systems | | | | | | | | | *X |

This is to certify that the above named student has demonstrated proficiency in the performance of the competencies and/or tasks indicated above. These competencies and/or tasks have been determined to be the skills and knowledge that are necessary for entry level employment into the job classifications indicated.

Date__________________ Instructor_________________________

School_____________________________

Instructor_________________________

Instructor_________________________

Instructor_________________________

Instructor_________________________

*Certificate of Competency can be issued

# CERTIFICATE OF COMPETENCY

This is to Certify that

Doug Adams

SAMPLE

Savannah Tech

has successfully mastered the competencies required to perform the job of

ELECTRIC METER INSTALLER

L. William Cobb

June 15, 1980

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electric Meter Installer.

## ELECTRIC METER INSTALLER
(D.O.T. Code 821.361-014)

### Introduction to Electricity/Electronics
Identifying sources of electrical energy
Identifying static electricity
Identifying principles of electric current
Identifying principles of electromagnetic induction
Identifying principles of current flow and resistance
Identifying resistors and capacitors
Identifying and using hand tools
Identifying conductors and fittings
Identifying DC circuits
Identifying AC circuits

### Alternating Current
Identifying characteristics of AC circuits
Identifying sine wave fundamentals
Calculating induction reactance
Calculating capacitive reactance
Identifying and calculating impedance
Identifying practical application of alternating current

### Measuring Instruments
Identifying operating principles of electrical meters
Measuring resistance and insulation
Identifying and using indicating instruments

### Protective Devices
Identifying and maintaining protective devices
Grounding AC circuits
Identifying applications of the National Electrical Code
Making basic electrical calculations
Identifying procedures for electrical safety and maintenance

V-13

# CERTIFICATE OF COMPETENCY

This is to Certify that

______________________________

of

______________________________

has successfully mastered the competencies required to perform the job of

ELECTRIC METER INSTALLER

______________________________

______________________________

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electric Meter Installer.

## ELECTRIC METER INSTALLER
(D.O.T. Code 821.361-014)

### Introduction to Electricity/Electronics
Identifying sources of electrical energy
Identifying static electricity
Identifying principles of electric current
Identifying principles of electromagnetic induction
Identifying principles of current flow and resistance
Identifying resistors and capacitors
Identifying and using hand tools
Identifying conductors and fittings
Identifying DC circuits
Identifying AC circuits

### Alternating Current
Identifying characteristics of AC circuits
Identifying sine wave fundamentals
Calculating induction reactance
Calculating capacitive reactance
Identifying and calculating impedance
Identifying practical application of alternating current

### Measuring Instruments
Identifying operating principles of electrical meters
Measuring resistance and insulation
Identifying and using indicating instruments

### Protective Devices
Identifying and maintaining protective devices
Grounding AC circuits
Identifying applications of the National Electrical Code
Making basic electrical calculations
Identifying procedures for electrical safety and maintenance

# CERTIFICATE OF COMPETENCY

This is to Certify that

______________________________

of

______________________________

has successfully mastered the competencies required to perform the job of

POWER TRANSFORMER REPAIRER

______________________________

____________________

V-15

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Power Transformer Repairer.

## POWER TRANSFORMER REPAIRER
(D.O.T. Code 821.361-034)

### Introduction to Electricity/Electronics
Identifying sources of electrical energy
Identifying static electricity
Identifying principles of electric current
Identifying principles of electromagnetic induction
Identifying principles of current flow and resistance
Identifying resistors and capacitors
Identifying and using hand tools
Identifying conductors and fittings
Identifying DC circuits
Identifying AC circuits

### Alternating Current
Identifying characteristics of AC circuits
Identifying sine wave fundamentals
Calculating induction reactance
Calculating capacitive reactance
Identifying and calculating impedance
Identifying practical application of alternating current
Identifying polyphase circuits and calculating phase and line voltage
Identifying principles of transformers
Identifying transformer connections and installation
Maintaining transformers

### Measuring Instruments
Identifying operating principles of electrical meters
Identifying and using DC instruments
Measuring resistance and insulation
Identifying operating principles of AC meters
Selecting a meter and making an AC measurement
Identifying and using power measuring instruments
Identifying and using special measuring instruments
Identifying and using indicating instruments

### Protective Devices
Identifying and maintaining protective devices
Identifying and maintaining circuit breakers
Identifying and maintaining overload relays
Identifying applications of protective devices
Grounding AC circuits
Identifying applications of the National Electrical Code
Making basic electrical calculations
Identifying wireway systems
Identifying methods of industrial illumination
Identifying procedures for electrical safety and maintenance

### Electrical Troubleshooting
Troubleshooting control circuits
Troubleshooting combination starters
Troubleshooting control devices
Troubleshooting special controls
Troubleshooting DC motors
Troubleshooting AC motors

V-17

# CERTIFICATE OF COMPETENCY

This is to Certify that

of

has successfully mastered the competencies required to perform the job of

ELECTRIC MOTOR ANALYST

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electric Motor Analyst.

## ELECTRIC MOTOR ANALYST
(D.O.T. Code 721.261-010)

### Introduction to Electricity/Electronics

- Identifying sources of electrical energy
- Identifying static electricity
- Identifying principles of electric current
- Identifying principles of electromagnetic induction
- Identifying principles of current flow and resistance
- Identifying resistors and capacitors
- Identifying and using hand tools
- Identifying conductors and fittings
- Identifying DC circuits
- Identifying AC circuits

### Electrochemical Action and DC

- Identifying basic principles of electrochemical action
- Identifying types of batteries
- Identifying the electrochemical action of batteries
- Performing battery maintenance
- Charging batteries and maintaining battery records
- Identifying fundamental DC circuits
- Identifying properties of DC circuits
- Identifying properties of DC parallel circuits
- Identifying series parallel circuits
- Identifying practical application of DC circuits

### Alternating Current

- Identifying characteristics of AC circuits
- Identifying sine wave fundamentals
- Calculating induction reactance
- Calculating capacitive reactance
- Identifying and calculating impedance
- Identifying practical application of alternating current
- Identifying polyphase circuits and calculating phase and line voltage
- Identifying principles and applications of electromagnetism in DC circuits
- Identifying applications of DC generators
- Identifying principles and applications of DC motors
- Identifying types of and maintaining DC armatures
- Identifying types and operating principles of DC relays
- Identifying DC controllers and their operating principles
- Identifying and maintaining DC power supplies
- Identifying principles and applications of silicon controlled rectifiers
- Performing basic DC circuit maintenance

### Single Phase Motors

- Identifying basic operating principles of single phase motors
- Identifying and maintaining split phase motors
- Identifying and maintaining capacitor motors
- Identifying and maintaining repulsion motors
- Identifying and maintaining universal motors
- Identifying special purpose single phase motors
- Identifying synchro-systems and applications
- Identifying servomechanisms and their principles of operation
- Identifying starting and protection devices for single phase motor
- Performing single phase motor maintenance and repairs

### Polyphase Systems

- Identifying basic principles of polyphase motors
- Identifying induction motors and their operating principles and maintaining them
- Identifying and maintaining synchronous motors
- Identifying, hooking up and operating multi-speed dual voltage
- Maintaining polyphase motors

### Measuring Instruments

Identifying operating principles of electrical meters
Identifying and using DC instruments
Measuring resistance and insulation
Identifying operating principles of AC meters
Selecting a meter and making an AC measurement
Identifying and using power measuring instruments
Identifying and using special measuring instruments
Identifying and using indicating instruments
Identifying recording instruments and procedures for instrument care and maintenance
Identifying and using electronic measuring instruments

### Protective Devices

Identifying and maintaining protective devices
Identifying and maintaining circuit breakers
Identifying and maintaining overload relays
Identifying applications of protective devices
Grounding AC circuits
Identifying applications of the *National Electrical Code*
Making basic electrical calculations
Identifying wireway systems
Identifying methods of industrial illumination
Identifying procedures for electrical safety and maintenance

### DC Equipment and Controls

Identifying sources of DC power for industry
Identifying basic principles of AC motor starting
Identifying polyphase motor controllers and their operating principles
Identifying alternators and their operating principles
Identifying and maintaining auxiliary generator systems
Identifying and maintaining power distribution systems

### AC Control Equipment

Identifying AC motor starter circuit components
Identifying and operating pushbutton control stations
Identifying limit switches and their applications
Identifying special control switches and their applications
Identifying types of timers and counters and their applications
Identifying and maintaining control relays
Identifying and maintaining types of industrial AC controls used in hazardous locations
Identifying special motor control circuits and related schematics
Identifying and installing motor control centers
Wiring a control panel

### Electrical Troubleshooting

Troubleshooting with electrical shematics
Troubleshooting electrical circuits using building drawings

V-21

# *CERTIFICATE OF COMPETENCY*

This is to Certify that

________________________________________

of

________________________________________

has successfully mastered the competencies required to perform the job of

ELECTRIC MOTOR ASSEMBLER AND TESTER

__________________________

_______________

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electric Motor Assembler and Tester.

## ELECTRIC MOTOR ASSEMBLER AND TESTER
(D.O.T. Code 721.281-014)

### Introduction to Electricity/Electronics
Identifying sources of electrical energy
Identifying static electricity
Identifying principles of electric current
Identifying principles of electromagnetic induction
Identifying principles of current flow and resistance
Identifying resistors and capacitors
Identifying and using hand tools
Identifying conductors and fittings
Identifying DC circuits
Identifying AC circuits

### Measuring Instruments
Identifying operating principles of electrical meters
Identifying and using DC instruments
Measuring resistance and insulation
Identifying operating principles of AC meters
Selecting a meter and making an AC measurement
Identifying and using power measuring instruments
Identifying and using special measuring instruments
Identifying and using indicating instruments
Identifying recording instruments and procedures for instrument care and maintenance
Identifying and using electronic measuring instruments

### Protective Devices
Identifying and maintaining protective devices
Identifying applications of the National Electrical Code
Identifying procedures for electrical safety and maintenance

### Single Phase Motors
Identifying basic operating principles of single phase motors
Identifying and maintaining split phase motors
Identifying and maintaining capacitor motors
Identifying and maintaining repulsion motors
Identifying and maintaining universal motors
Identifying special purpose single phase motors
Identifying synchro-systems and applications
Identifying servomechanisms and their principles of operation
Identifying starting and protection devices for single phase motor
Performing single phase motor maintenance and repairs

### Polyphase Systems
Identifying basic principles of polyphase motors
Identifying induction motors and their operating principles and maintaining them
Identifying and maintaining synchronous motors
Identifying, hooking up and operating multi-speed dual voltage
Maintaining polyphase motors
Identifying basic principles of AC motor starting
Identifying polyphase motor controllers and their operating principles
Identifying alternators and their operating principles
Identifying and maintaining auxiliary generator systems
Identifying and maintaining power distribution systems

# CERTIFICATE OF COMPETENCY

This is to Certify that

______________________________________________

of

______________________________________________

has successfully mastered the competencies required to perform the job of

ELECTRIC MOTOR REPAIRER

__________________________

______________

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electric Motor Repairer.

## ELECTRIC MOTOR REPAIRER
(D.O.T. Code 721.281-018)

### Introduction to Electricity/Electronics
Identifying sources of electrical energy
Identifying static electricity
Identifying principles of electric current
Identifying principles of electromagnetic induction
Identifying principles of current flow and resistance
Identifying resistors and capacitors
Identifying and using hand tools
Identifying conductors and fittings
Identifying DC circuits
Identifying AC circuits

### Measuring Instruments
Identifying operating principles of electrical meters
Identifying and using DC instruments
Measuring resistance and insulation
Identifying operating principles of AC meters
Selecting a meter and making an AC measurement
Identifying and using power measuring instruments
Identifying and using special measuring instruments
Identifying and using indicating instruments
Identifying recording instruments and procedures for instrument care and maintenance
Identifying and using electronic measuring instruments

### Protective Devices
Identifying and maintaining protective devices
Identifying and maintaining circuit breakers
Identifying and maintaining overload relays
Identifying applications of protective devices
Grounding AC circuits
Identifying applications of the National Electrical Code
Making basic electrical calculations
Identifying wireway systems
Identifying methods of industrial illumination
Identifying procedures for electrical safety and maintenance

### Single Phase Motors
Identifying basic operating principles of single phase motors
Identifying and maintaining split phase motors
Identifying and maintaining capacitor motors
Identifying and maintaining repulsion motors
Identifying and maintaining universal motors
Identifying special purpose single phase motors
Identifying synchro-systems and applications
Identifying servomechanisms and their principles of operation
Identifying starting and protection devices for single phase motors
Performing single phase motor maintenance and repairs

### Polyphase Systems
Identifying basic principles of polyphase motors
Identifying induction motors and their operating principles and maintaining them
Identifying and maintaining synchronous motors
Identifying, hooking up and operating multi-speed dual voltage
Maintaining polyphase motors
Identifying basic principles of AC motor starting
Identifying polyphase motor controllers and their operating principles
Identifying alternators and their operating principles
Identifying and maintaining auxiliary generator systems
Identifying and maintaining power distribution systems

### AC Control Equipment
Identifying AC motor starter circuit components
Identifying and operating pushbutton control stations
Identifying limit switches and their applications
Identifying special control switches and their applications
Identifying types of timers and counters and their applications
Identifying and maintaining control relays
Identifying and maintaining types of industrial AC controls used in hazardous locations
Identifying special motor control circuits and related schematics
Identifying and installing motor control centers
Wiring a control panel

### Electrical Troubleshooting
Troubleshooting with electrical schematics
Troubleshooting control circuits
Troubleshooting AC motors

V-25

# CERTIFICATE OF COMPETENCY

This is to Certify that

of

has successfully mastered the competencies required to perform the job of

ELECTRICIAN

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electrician.

## ELECTRICIAN
## (D.O.T. Code 824.261-010)

### Introduction to Electricity/Electronics

Identifying sources of electrical energy
Identifying static electricity
Identifying principles of electric current
Identifying principles of electromagnetic induction
Identifying principles of current flow and resistance
Identifying resistors and capacitors
Identifying and using hand tools
Identifying conductors and fittings
Identifying DC circuits
Identifying AC circuits

### Electrochemical Action and DC

Identifying basic principles of electrochemical action
Identifying types of batteries
Identifying the electrochemical action of batteries
Performing battery maintenance
Charging batteries and maintaining battery records
Identifying fundamental DC circuits
Identifying properties of DC circuits
Identifying properties of DC parallel circuits
Identifying series parallel circuits
Identifying practical application of DC circuits

### Alternating Current

Identifying characteristics of AC circuits
Identifying sine wave fundamentals
Calculating induction reactance
Calculating capacitive reactance
Identifying and calculating impedance
Identifying practical application of alternating current
Identifying polyphase circuits and calculating phase and line voltage
Identifying principles of transformers
Identifying transformer connections and installation
Maintaining transformers

### Measuring Instruments

Identifying operating principles of electrical meters
Identifying and using DC instruments
Measuring resistance and insulation
Identifying operating principles of AC meters
Selecting a meter and making an AC measurement
Identifying and using power measuring instruments
Identifying and using special measuring instruments
Identifying and using indicating instruments
Identifying recording instruments and procedures for instrument care and maintenance
Identifying and using electronic measuring instruments

### Protective Devices

Identifying and maintaining protective devices
Identifying and maintaining circuit breakers
Identifying and maintaining overload relays
Identifying applications of protective devices
Grounding AC circuits
Identifying applications of the National Electrical Code
Making basic electrical calculations
Identifying wireway systems
Identifying methods of industrial illumination
Identifying procedures for electrical safety and maintenance

# CERTIFICATE OF COMPETENCY

This is to Certify that

____________________

of

____________________

has successfully mastered the competencies required to perform the job of

ELECTRICAL TECHNICIAN

____________________

____________________

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electrical Technician.

## ELECTRICAL TECHNICIAN
(D.O.T. Code 003.161-010)

### Introduction to Electricity/Electronics

Identifying sources of electrical energy
Identifying static electricity
Identifying principles of electric current
Identifying principles of electromagnetic induction
Identifying principles of current flow and resistance
Identifying resistors and capacitors
Identifying and using hand tools
Identifying conductors and fittings
Identifying DC circuits
Identifying AC circuits

### Electrochemical Action and DC

Identifying basic principles of electrochemical action
Identifying types of batteries
Identifying the electrochemical action of batteries
Performing battery maintenance
Charging batteries and maintaining battery records
Identifying fundamental DC circuits
Identifying properties of DC circuits
Identifying properties of DC parallel circuits
Identifying series parallel circuits
Identifying practical application of DC circuits

### Alternating Current

Identifying characteristics of AC circuits
Identifying sine wave fundamentals
Calculating induction reactance
Calculating capacitive reactance
Identifying and calculating impedance
Identifying practical application of alternating current
Identifying polyphase circuits and calculating phase and line voltage
Identifying principles and applications of DC motors
Identifying types of and maintaining DC armatures
Identifying types and operating principles of DC relays
Identifying DC controllers and their operating principles
Identifying and maintaining DC power supplies
Identifying principles and applications of silicon controlled rectifiers
Performing basic DC circuit maintenance

### Single Phase Motors

Identifying basic operating principles of single phase motors
Identifying and maintaining split phase motors
Identifying and maintaining capacitor motors
Identifying and maintaining repulsion motors
Identifying and maintaining universal motors
Identifying special purpose single phase motors
Identifying synchro-systems and applications
Identifying servomechanisms and their principles of operation
Identifying starting and protection devices for single phase motor
Performing single phase motor maintenance and repairs

### Polyphase Systems

Identifying basic principles of polyphase motors
Identifying induction motors and their operating principles and maintaining them
Identifying and maintaining synchronous motors
Identifying, hooking up and operating multi-speed dual voltage
Maintaining polyphase motors
Identifying basic principles of AC motor starting
Identifying polyphase motor controllers and their operating principles

Identifying principles of transformers
Identifying transformer connections and installation
Maintaining transformers

### Measuring Instruments

Identifying operating principles of electrical meters
Identifying and using DC instruments
Measuring resistance and insulation
Identifying operating principles of AC meters
Selecting a meter and making an AC measurement
Identifying and using power measuring instruments
Identifying and using special measuring instruments
Identifying and using indicating instruments
Identifying recording instruments and procedures for instrument care and maintenance
Identifying and using electronic measuring instruments

### Protective Devices

Identifying and maintaining protective devices
Identifying and maintaining circuit breakers
Identifying and maintaining overload relays
Identifying applications of protective devices
Grounding AC circuits
Identifying applications of the National Electrical Code
Making basic electrical calculations
Identifying wireway systems
Identifying methods of industrial illumination
Identifying procedures for electrical safety and maintenance

### DC Equipment and Controls

Identifying sources of DC power for industry
Identifying principles and applications of electromagnetism in DC circuits
Identifying applications of DC generators
Identifying alternators and their operating principles
Identifying and maintaining auxiliary generator systems
Identifying and maintaining power distribution systems

### AC Control Equipment

Identifying AC motor starter circuit components
Identifying and operating pushbutton control stations
Identifying limit switches and their applications
Identifying special control switches and their applications
Identifying types of timers and counters and their applications
Identifying and maintaining control relays
Identifying and maintaining types of industrial AC controls used in hazardous locations
Identifying special motor control circuits and related schematics
Identifying and installing motor control centers
Wiring a control panel

### Electrical Troubleshooting

Troubleshooting with electrical schematics
Troubleshooting electrical circuits using building drawings
Troubleshooting control circuits
Troubleshooting combination starters
Troubleshooting control devices
Troubleshooting special controls
Troubleshooting DC motors
Troubleshooting AC motors
Troubleshooting lighting systems

## GROUP PROGRESS CHART

| NAME | UNITS/TASKS | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

# SECTION VI

## FACILITIES

# SECTION VI

## Section VI Content List

Group Instruction Facilities
Individualized Instruction Facilities

The facility layouts on the following pages are presented to aid in arranging the classroom and laboratory for efficient instruction. The school administration and program instructor must determine an arrangement that best fits the needs of the students by determining the most efficient use of resources available to them not only in the laboratory, but also in the Learning Resource Center settings.

# FACILITY LAYOUTS

The layouts on the following pages illustrate how facilities for group and individualized instructional programs may be planned and set up.

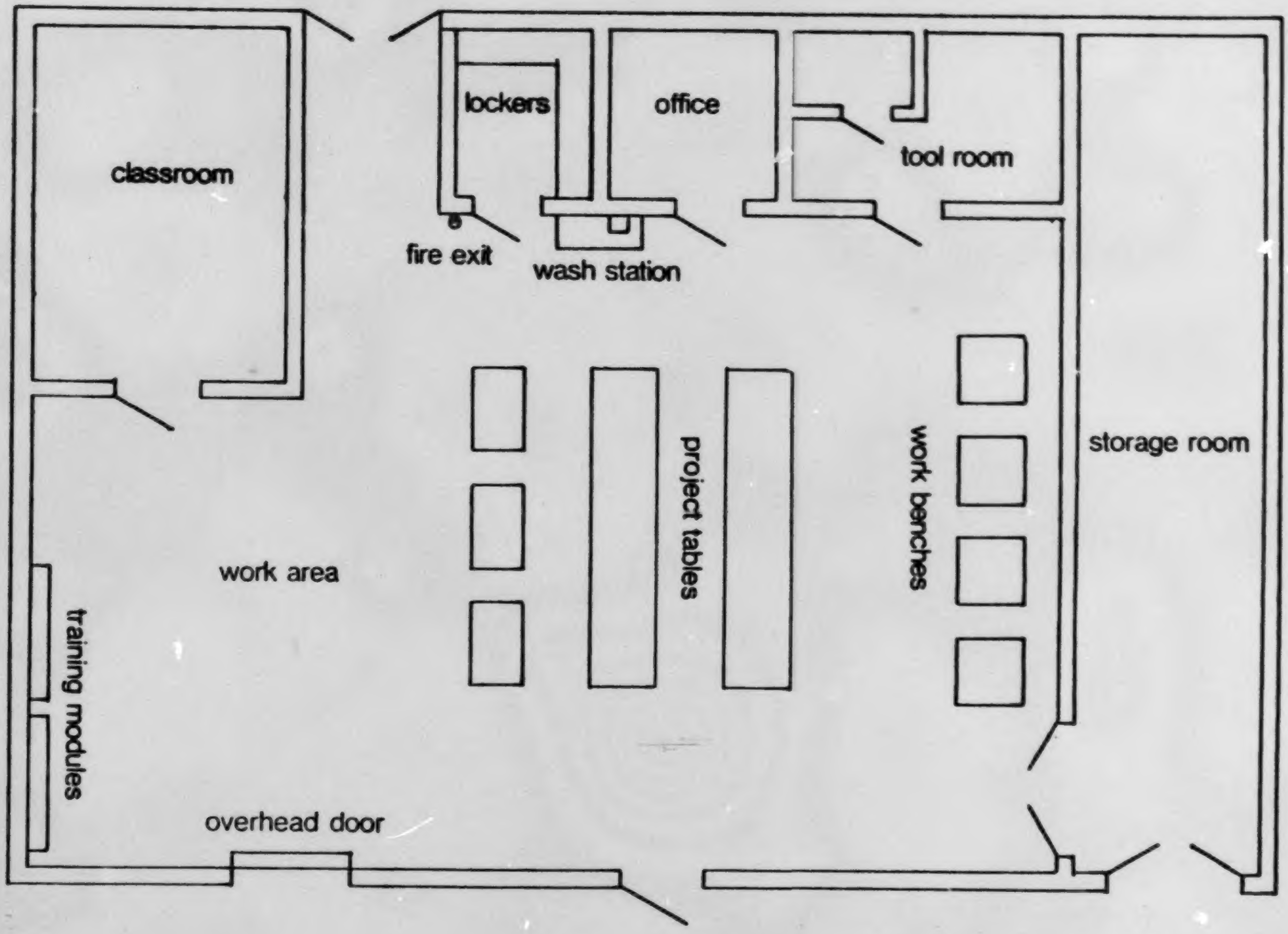
Each instructional approach has two important physical areas. These are (1) the laboratory (work) area and classroom for group instruction and (2) the laboratory (work) area and learning resource center (LRC) for individualized instruction.

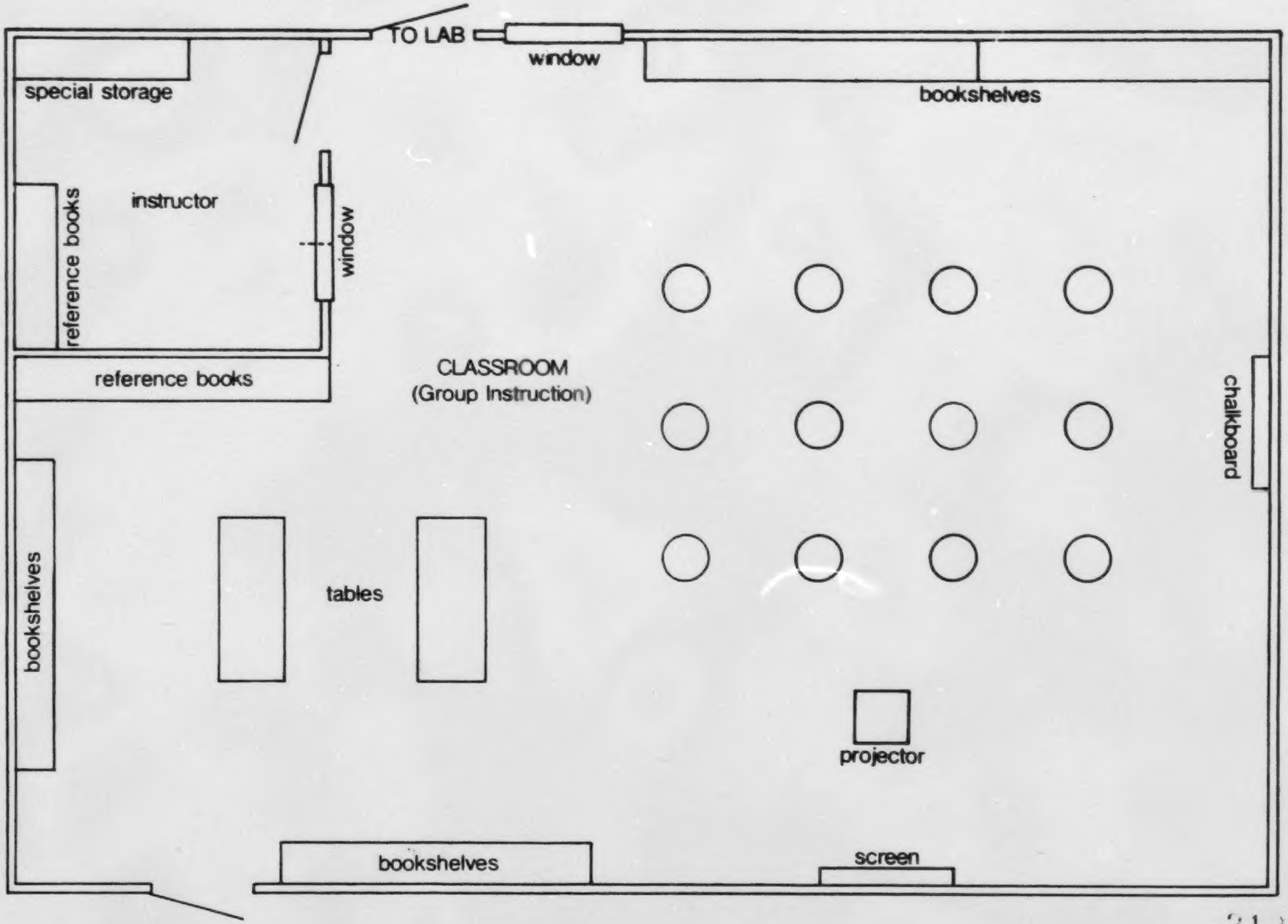
The instructional setting for group instruction is based on that of a traditional classroom. This approach is easily set up and includes little or no modifications. The primary modes of learning are instructor lectures, occasional use of audiovisual aids and student participation. Ideally, all students progress at the same pace.

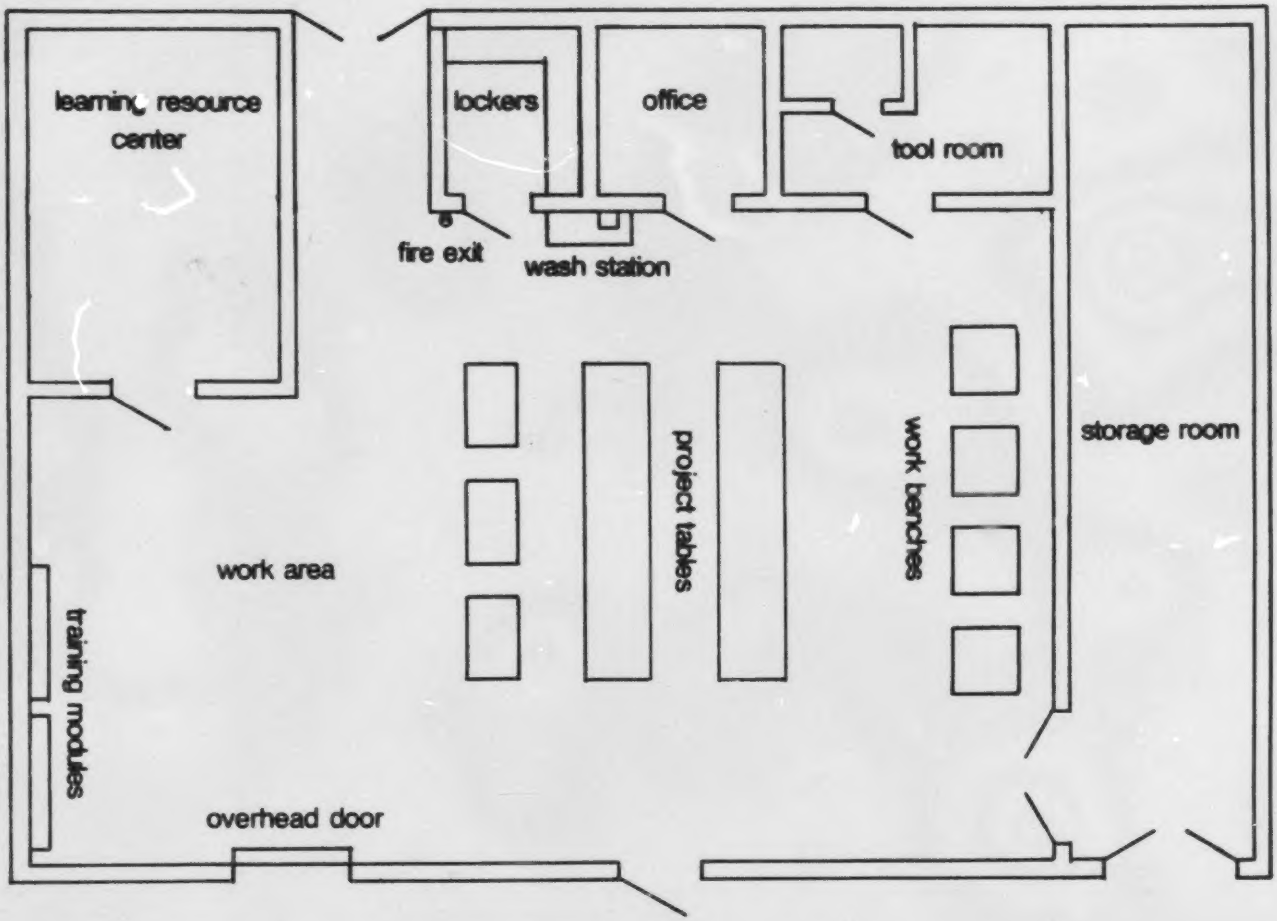
The instructional setting for individual instruction is designed to facilitate a student self-paced progression of learning. The LRC requires careful planning in utilizing available space. When planning to install an individual instruction program in an area not originally designed for this approach, the instructional setting may need modifications. Desks may be replaced with study carrels to allow students to simultaneously participate in a variety of learning activities. A group session area for small group gatherings should also be included. Because the instructor and students rarely meet together as a group, a bulletin board becomes a vital communication device in an LRC. It can be used to post announcements and such instructional information as group progress charts, assignments, positions available in the industry and safety rules.

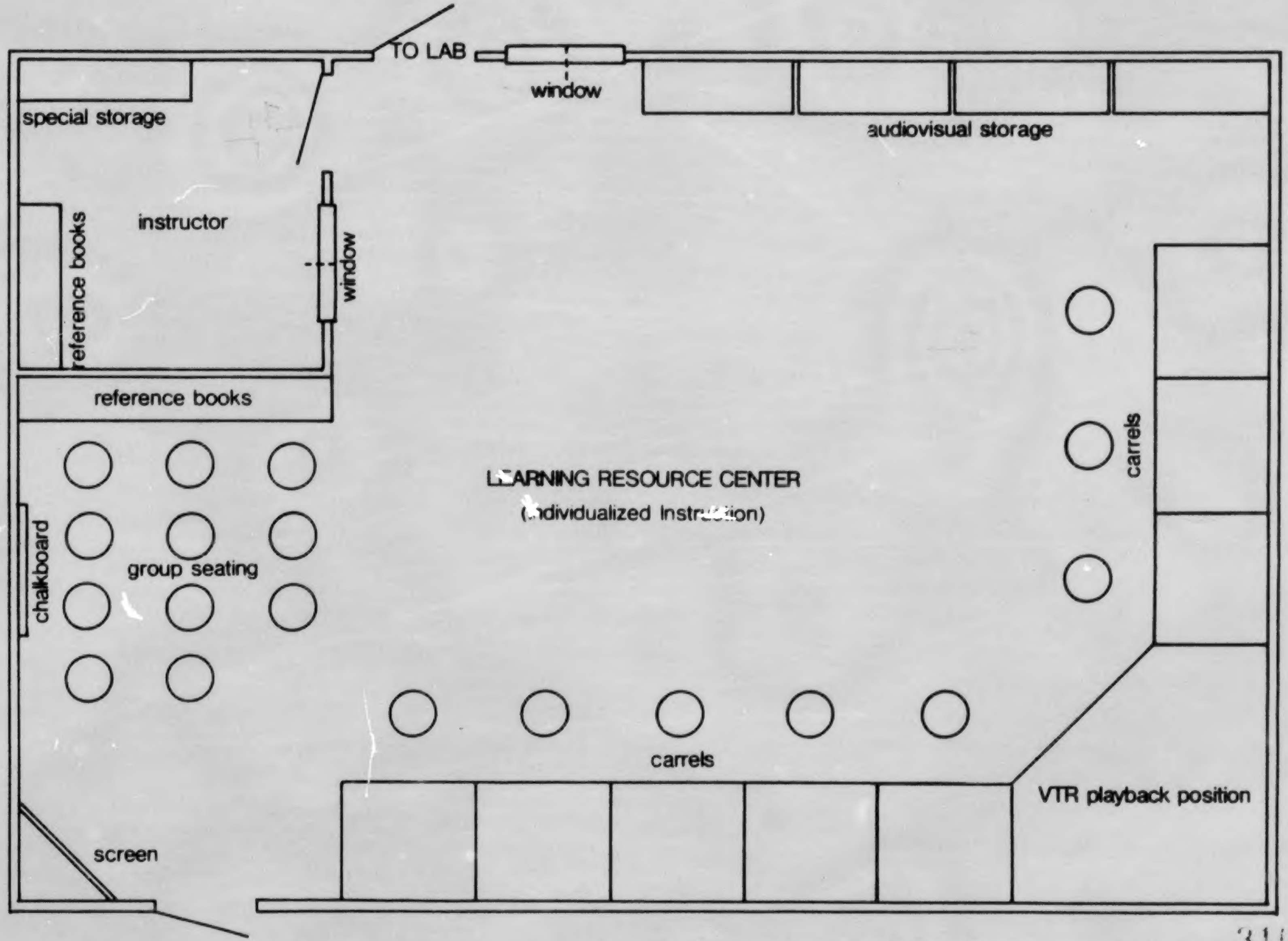
A variety of references, resources and media equipment should be made available to the student. Therefore, an adequate amount of storage area should be included in planning the LRC. Every specific school and department has unique physical layout characteristics and problems. Through innovation, these features may be transformed into LRC advantages rather than disadvantages.

The manner in which the laboratory (work) area is planned and set up need not be affected by the type of instructional approach used by an instructor; it could/will be the same. Some major concerns in the laboratory are: 1) the instructor must always have a clear line of sight to each and every workstation, 2) tools must be accessible to students, but under the control of the instructor and 3) all supplies and materials required for the day's activities must be on hand and ready to use.


classroom
lockers
office
tool room
fire exit
wash station
project tables
work benches
storage room
work area
training modules
overhead door


TO LAB
window
special storage
bookshelves
instructor
reference books
window
reference books
CLASSROOM
(Group Instruction)
chalkboard
bookshelves
tables
projector
bookshelves
screen


learning resource center
lockers
office
tool room
fire exit
wash station
project tables
work benches
storage room
work area
training modules
overhead door


TO LAB
window
special storage
audiovisual storage
instructor
reference books
window
reference books
LEARNING RESOURCE CENTER
(Individualized Instruction)
carrels
chalkboard
group seating
carrels
VTR playback position
screen

# APPENDIX A

## Resources

# RESOURCES

This appendix contains the instructional resource matrix, unit guide reference and additional instructional materials.

The instructional resource matrix lists the audiovisuals, textbooks and student manuals for each task referenced on the unit guide sheets. The audiovisual format is identified by the symbols such as: filmstrip (FS), slide/script (SS), slide/tape (ST), 16mm movie film (MF), transparency (TR), video tape (VT) and filmloop (FL). The producer, title and number of the A/V is also given.

The unit guide bibliography lists textbooks, audiovisuals and student manuals cited in the unit guides section.

The additional instructional materials is a compilation of textbooks not included in the unit guides but beneficial to educators.

Resources addresses for all references concludes this appendix.

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| IE-01 Identifying sources of electrical energy | Bergwall: "Basic Electricity and Electronics Explained," (FS); AAVIM: "Electrical Energy," (ST) | Training and Retraining, Inc.: Basic Electricity/Electronics; AAVIM: Understanding Electricity and Electrical Terms | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson One |
| IE-02 Identifying static electricity | Bergwall: "Basic Electricity and Electronics Explained," (FS); AAVIM: "Electrical Energy," (ST) | Training and Retraining, Inc.: Basic Electricity/Electronics; AAVIM: Understanding Electricity and Electrical Terms; Howard W. Sams: ABC's of Electricity | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Two |
| IE-03 Identifying principles of electric current and voltage | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Three |
| IE-04 Identifying principles of electromagnetic induction | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper, Introduction to Electricity and Electronics | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Four |
| IE-05 Identifying principles of current flow and resistance | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper, Introduction to Electricity and Electronics | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Five |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|---|
| | | Audiovisuals | Textbooks | Student Materials |
| IE-06 | Identifying resistors and capacitors | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Six |
| IE-07 | Identifying and using hand tools | | Dover: Tools and Their Uses | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Seven |
| IE-08 | Identifying conductors and fittings | | NEC Handbook; Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Eight |
| IE-09 | Identifying DC circuits | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper, Introduction to Electricity and Electronics | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Nine |
| IE-10 | Identifying AC circuits | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper, Introduction to Electricity and Electronics | Plant Engineering Training Systems: Introduction to Electricity and Electronics, Lesson Ten |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| EC-01 Identifying basic principles of electrochemical action | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson One |
| EC-02 Identifying types of batteries | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Two |
| EC-03 Identifying the electrochemical action of batteries | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Three |
| EC-04 Performing battery maintenance | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Four |
| EC-05 Charging batteries and maintaining battery records | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Five |
| EC-06 Identifying fundamental DC circuits | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Six |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| EC-07 Identifying properties of DC series circuits | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Seven |
| EC-08 Identifying properties of DC parallel circuits | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Eight |
| EC-09 Identifying series parallel circuits | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Nine |
| EC-10 Identifying practical applications of DC circuits | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrochemical Action and DC, Lesson Ten |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|---|
| | | Audiovisuals | Textbooks | Student Materials |
| AC-01 | Identifying characteristics of AC circuits | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson One |
| AC-02 | Identifying sine wave fundamentals | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Two |
| AC-03 | Calculating inductive reactance | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Three |
| AC-04 | Calculating capacitive reactance | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Four |
| AC-05 | Identifying and calculating impedance | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Five |
| AC-06 | Identifying practical applications of alternating current | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Six |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|---|
| | | Audiovisuals | Textbooks | Student Materials |
| AC-07 | Identifying polyphase circuits and calculating phase and line voltage | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Seven |
| AC-08 | Identifying principles of transformers | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Eight |
| AC-09 | Identifying transformer connections, applications and installations | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Nine |
| AC-10 | Maintaining transformers | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Circuits, Lesson Ten |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| MI-01 Identifying operating principles of electric meters | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson One |
| MI-02 Identifying and using DC instruments | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Two |
| MI-03 Measuring resistance and insulation | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Three |
| MI-04 Identifying operating principles of AC meters | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Four |
| MI-05 Selecting a meter and making an AC measurement | Bergwall: "Basic Electricity and Electronics Explained," (FS) | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Five |
| MI-06 Identifying and using power measuring instruments | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Six |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| MI-07 Identifying and using special measuring instruments | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Seven |
| MI-08 Identifying and using indicating instruments | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Eight |
| MI-09 Identifying recording instruments and procedures for instrument care and maintenance | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Nine |
| MI-10 Identifying and using electronic measuring instruments | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Measuring Instruments, Lesson Ten |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| PD-01 Identifying and maintaining protective devices | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems, Protective Devices, Lesson One |
| PD-02 Identifying and maintaining circuit breakers | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems, Protective Devices, Lesson Two |
| PD-03 Identifying and maintaining overload relays | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems, Protective Devices, Lesson Three |
| PD-04 Identifying applications of protective devices | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems, Protective Devices, Lesson Four |
| PD-05 Grounding AC circuits | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems, Protective Devices, Lesson Five |
| PD-06 Identifying applications of the National Electrical Code | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics; NEC Handbook | Plant Engineering Training Systems, Protective Devices, Lesson Six |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| PD-07 Making basic electrical calculations | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics; NEC Handbook | Plant Engineering Training Systems, Protective Devices, Lesson Seven |
| PD-08 Identifying wireway systems | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics; NEC Handbook; Manufacturer's catalogs | Plant Engineering Training Systems, Protective Devices, Lesson Eight |
| PD-09 Identifying methods of industrial illumination | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems, Protective Devices, Lesson Nine |
| PD-10 Identifying procedures for electrical safety and maintenance | Hobar: "Power Tool Safety and Operation," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems, Protective Devices, Lesson Ten |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|---|
| | | Audiovisuals | Textbooks | Student Materials |
| DC-01 | Identifying sources of DC power in industry | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: DC Equipment and Controls, Lesson One |
| DC-02 | Identifying principles and applications of DC generators | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: DC Equipment and Controls, Lesson Two |
| DC-03 | Identifying applications of DC generators | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: DC Equipment and Controls, Lesson Three |
| DC-04 | Identifying principles and applications of DC motors | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: DC Equipment and Controls, Lesson Four |
| DC-05 | Identifying types of DC armatures and maintaining them | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: DC Equipment and Controls, Lesson Five |
| DC-06 | Identifying types and operating princi- of DC relays | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: DC Equipment and Controls, Lesson Six |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| DC-07 Identifying DC controllers and their operating principles | | Training and Retraining, Inc.: *Basic Electricity/ Electronics*; Loper: *Introduction to Electricity and Electronics* | Plant Engineering Training Systems: *DC Equipment and Controls, Lesson Seven* |
| DC-08 Identifying and maintaining DC power supplies | | Training and Retraining, Inc.: *Basic Electricity/ Electronics*; Loper: *Introduction to Electricity and Electronics* | Plant Engineering Training Systems: *DC Equipment and Controls, Lesson Eight* |
| DC-09 Identifying principles and applications of silicon controlled rectifiers | | Training and Retraining, Inc.: *Basic Electricity/ Electronics*; Loper: *Introduction to Electricity and Electronics* | Plant Engineering Training Systems: *DC Equipment and Controls, Lesson Nine* |
| DC-10 Performing basic DC circuit maintenance | | Training and Retraining, Inc.: *Basic Electricity/ Electronics*; Loper: *Introduction to Electricity and Electronics* | Plant Engineering Training Systems: *DC Equipment and Controls, Lesson Ten* |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| SP-01 Identifying basic operating principles of single-phase motors | Career Aids, Inc.: "How Electric Motors Start and Run," (ST,FS) | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson One |
| SP-02 Identifying and maintaining split-phase motors | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson Two |
| SP-03 Identifying and maintaining capacitor motors | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson Three |
| SP-04 Identifying and maintaining repulsion motors | | Training and Retraining, Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson Four |
| SP-05 Identifying and maintaining universal motors | | Training and Retraining Inc.: Basic Electricity/ Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson Five |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| SP-06 Identifying special purpose single-phase motors | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson Six |
| SP-07 Identifying synchro systems and applications | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson Seven |
| SP-08 Identifying servomechanisms and their principles of operation | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson Eight |
| SP-09 Identifying starting and protection devices for single-phase motors | Career Aids, Inc.: "How Electric Motors Start and Run," (ST,FS) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics; NEC Handbook | Plant Engineering Training Systems: Single-Phase Motors, Lesson Nine |
| SP-10 Performing single-phase motor maintenance and repair | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Single-Phase Motors, Lesson Ten |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| ACC-01 Identifying AC motor starter circuit and components | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson One |
| ACC-02 Identifying and operating pushbutton control stations | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Two |
| ACC-03 Identifying limit switches and their applications | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Three |
| ACC-04 Identifying special control switches and their applications | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Four |
| ACC-05 Identifying types of timers and counters and their applications | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Five |
| ACC-06 Identifying and maintaining control relays | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Six |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|---|
| | | Audiovisuals | Textbooks | Student Materials |
| ACC-07 | Identifying and maintaining types of industrial AC controls used in hazardous locations | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Seven |
| ACC-08 | Identifying special motor control circuit and related schematics | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Eight |
| ACC-09 | Identifying and installing motor control centers | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Nine |
| ACC-10 | Wiring a control panel | Hobar: "Electric and Basic Controls," (TR) | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: AC Control Equipment, Lesson Ten |

**CURRICULUM AREA:** ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| ET-01 Troubleshooting with electrical schematics | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson One |
| ET-02 Troubleshooting electrical circuits using building drawings | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson Two |
| ET-03 Troubleshooting control circuits | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson Three |
| ET-04 Troubleshooting combination starters | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson Four |
| ET-05 Troubleshooting control devices | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson Five |
| ET-06 Troubleshooting special controls | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson Six |

CURRICULUM AREA: ELECTRICAL TECHNOLOGY

| TASK LISTING | INSTRUCTIONAL MATERIAL REFERENCES | | |
|---|---|---|---|
| | Audiovisuals | Textbooks | Student Materials |
| ET-07 Troubleshooting DC motors | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson Seven |
| ET-08 Troubleshooting AC motors | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson Eight |
| ET-09 Troubleshooting lighting systems | | Training and Retraining, Inc.: Basic Electricity/Electronics; Loper: Introduction to Electricity and Electronics | Plant Engineering Training Systems: Electrical Troubleshooting, Lesson Nine |

## TEXTBOOKS

Loper, Orla E., Ahr, Arthur F., and Clardenning, Lee R., *Introduction to Electricity and Electronics*. Albany, NY: Delmar Publishers, 1979.

Training and Retraining, Inc., *Basic Electricity and Electronics*. New York: Bobbs-Merrill Co., Inc., 1971.

## AUDIOVISUALS

| | |
|---|---|
| Hobar Publications | Transparencies, filmstrip |
| Bobbs-Merrill Educational Publishing | Slide/tape |
| Howard W. Sams and Co., Inc. | Slide/tape |
| Bergwall Productions, Inc. | Filmstrip |
| Career Aids, Inc. | Filmstrip, slide/tape |
| AAVIM | Transparencies, slide/tape |

## ADDITIONAL INSTRUCTIONAL RESOURCES

ABC's of Electric Motors and Generators. Indianapolis, IN: Howard W. Sams and Sons, Inc.

Alerich, Walter N., Electricity 3-DC Motors and Generators, Controls, Transformers. Albany: NY: Delmar Publishers, 1980.

Alerich, Walter N., Electricity 4-AC Motors and Generators, Controls, Alternators. Albany, NY: Delmar Publishers, 1980.

Electrical Motor Controls and Circuits. Indianapolis, IN: Howard W. Sams and Sons, Inc.

Heiserman, Russell; Bunson, Jack, Motors and Generators. New York, NY: Gregg/McGraw-Hill, 1980.

How to Read Schematic Diagrams (2nd ed.). Indianapolis, IN: Howard W. Sams and Sons, Inc.

Hubert, Charles I., Preventive Maintenance of Electrical Equipment (2nd ed.). New York, NY: Gregg/McGraw-Hill, 1969.

Kubula, Thomas S. Electricity 1 - Devices, Circuits, Materials. Albany, NY: Delmar Publishers, 1980.

Kubula, Thomas S. Electricity 2 - Devices, Circuits, Materials. Albany, NY: Delmar Publishers, 1980.

Miller, Rex, Industrial Electricity. Peoria, IL: Bennett Publishing Company.

Principles of Illumination. Indianapolis, IN: Howard W. Sams and Sons, Inc.

Smith, Robert L., Electrical Wiring - Industrial. Albany, NY: Delmar Publishers, 1978.

Traister, John E., Electrical Blueprint Reading. Indianapolis, IN: Bobbs-Merrill Educational Publishing, 1975.

Zbar, Paul B., Basic Electricity (4th ed.). New York, NY: Gregg/McGraw-Hill, 1974.

# RESOURCE ADDRESSES

AAVIM
120 Engineering Center
Athens, GA 30602

Bennett Publishing Company
809 W. Detweiller Drive
Department E81
Peoria, IL 61615

Bergwall Productions
839 Stewart Avenue
Garden City, NY 11530

Bobbs-Merrill Educational Publishing
4300 West 62nd Street
P.O. Box 7080
Indianapolis, IN 46206

Career Aids, Inc.
8950 Lurline Avenue
Department T7
Chatsworth, CA 91311

Delmar Publishers, Inc.
50 Wolf Road
Albany, NY 12205

Gregg/McGraw-Hill
1227 Avenue of the Americas
New York, NY 10020

Hobar Publications
1234 Tiller Lane
St. Paul, MN 55112

Howard W. Sams and Sons, Inc.
4300 West 62nd Street
P.O. Box 7080
Indianapolis, IN 46206

# APPENDIX B

## Special Needs

## WORKING WITH SPECIAL NEEDS STUDENTS*

### Introduction

Special needs population students are those who are designated as handicapped or disadvantaged. The 1976 vocational education amendments define handicapped individuals as:

> Persons who are mentally retarded, hard of hearing, deaf, speech impaired, visually handicapped, seriously emotionally disturbed, orthopedically impaired, health impaired, or persons with other specific disabilities, who by reason thereof require special education and related services and who cannot succeed in the regular vocational education programs.

In those same amendments disadvantaged persons are defined as:

> Persons (other than handicapped persons) who have academic or economic disadvantages and who require special services, assistance or programs in order to enable them to succeed in vocational education programs.

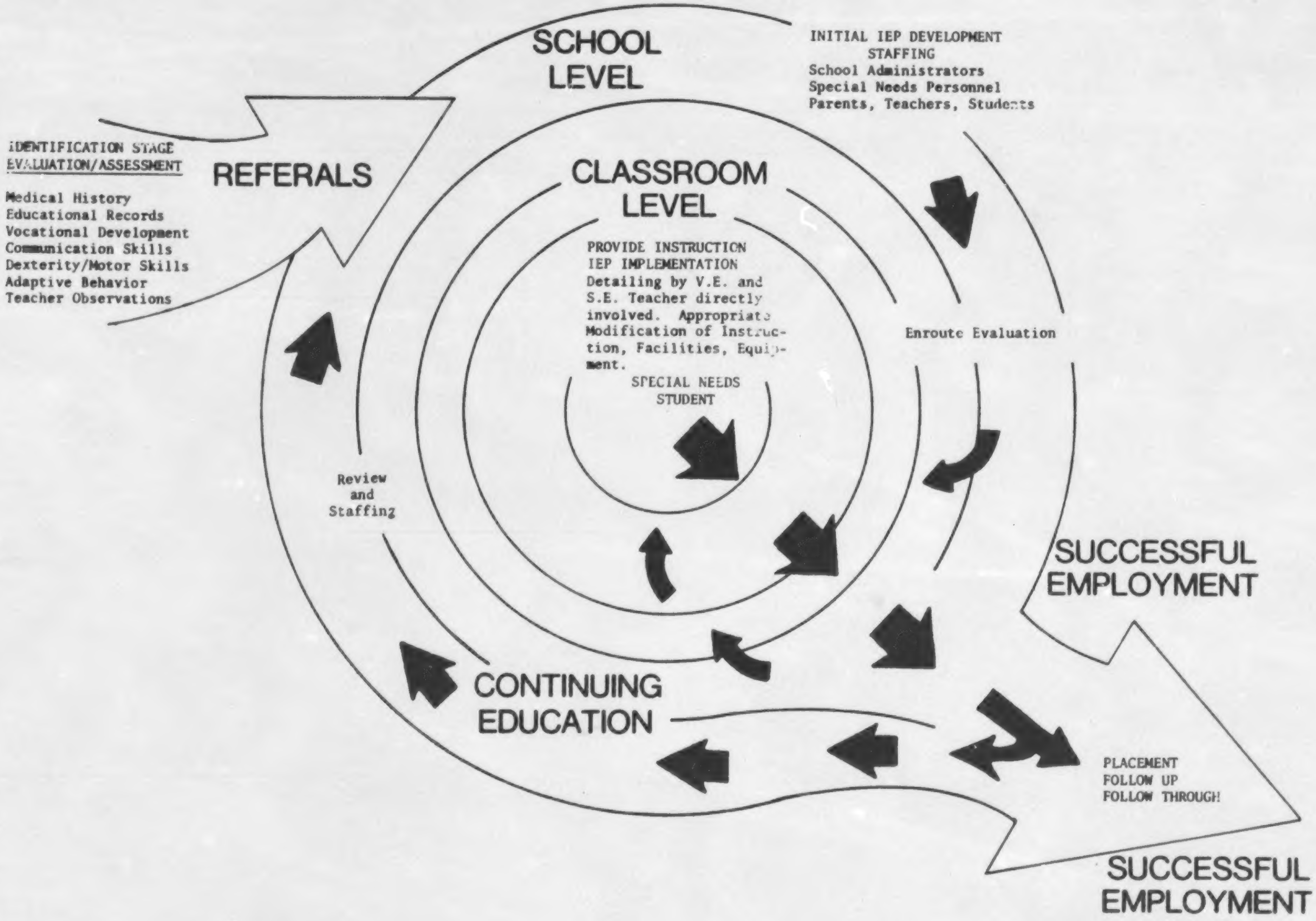
Federal legislation requires that these special needs population students be given an opportunity to function in regular vocational education programs (Essentially, this is what is meant by the term mainstreaming.). This section provides information on how such students are identified and how they can be mainstreamed into regular vocational education environments.

Figure One presents a conceptual model depicting various activities of the process in identifying and mainstreaming special needs students in vocational education. These activities

---

*The project director wishes to thank Mrs. Ann Lary, State Department of Education staff and Mrs. Rhonda Packer, VEMC staff, for their careful review of this section and for their suggestions that improved the overall value of this paper. Appreciation is also extended to Ray Butler for his patient work in reviewing and sorting available resources.

# THE CONCEPT OF MAINSTREAMING


SCHOOL LEVEL
INITIAL IEP DEVELOPMENT
STAFFING
School Administrators
Special Needs Personnel
Parents, Teachers, Students
IDENTIFICATION STAGE
EVALUATION/ASSESSMENT
Medical History
Educational Records
Vocational Development
Communication Skills
Dexterity/Motor Skills
Adaptive Behavior
Teacher Observations
REFERALS
CLASSROOM LEVEL
PROVIDE INSTRUCTION
IEP IMPLEMENTATION
Detailing by V.E. and S.E. Teacher directly involved. Appropriate Modification of Instruction, Facilities, Equipment.
SPECIAL NEEDS STUDENT
Enroute Evaluation
Review and Staffing
SUCCESSFUL EMPLOYMENT
CONTINUING EDUCATION
PLACEMENT
FOLLOW UP
FOLLOW THROUGH
SUCCESSFUL EMPLOYMENT

are conducted at three levels: the community level, the school level (Career Development Center) and the classroom level. All three levels must work together if implementation of the process is to be effective.

## Identification of the Special Needs Student

Through a variety of pre-testing procedures, special needs students are identified and their potentials are evaluated at the community level. This evaluation process consists of collecting and assessing the following data for each student:

- Medical History
- Educational Records
- Vocational Development
- Communication Skills
- Dexterity/Motor Skills
- Adaptive Behavior
- Teacher Observations

When this procedure has been completed, the community personnel refers the student to the appropriate school level personnel. As a part of the referral and school intake process, an Individualized Educational Plan should be initiated.

> The Individualized Educational Plan (IEP) is exactly what its name implies--a plan for the education of a specific individual. The base content of the IEP is outlined in Public Law 94-142. According to that outline, the IEP must include at least the following information: (a) student's present level of functioning, (b) his/her long range instructional objectives, (c) his/her short-range instructional objectives and finally, (d) some criteria to determine that those objectives have been achieved.

## Development of the Individual Education Plan

It would be very difficult to anticipate the exact kind or type of special needs students one might find in an Electrical Technology program at any one time. The terms disadvantaged and handicapped are really "catch-all" terms that indicate a wide assortment of problems that might occur in a student representing one of these populations. In addition to the lack of a specific definition and the fact that the typical vocational instructor has had very little preparation in working with these students, it becomes clear that you will need a basic plan to use in meeting their occupational preparation needs. The following steps can serve as your basic planning procedure for mainstreaming a special needs population student into your curriculum.

The first step occurs after you have been notified that a special needs student can profit from being in your vocational program. When you have received that notification, you should contact your coordinator of student personnel services and ask for a detailed report of the student's assessed status. Note the word assessed; it is critical. Through a formal assessment status, appropriate school personnel and community should have identified the student's strengths and weaknesses as well as the specific handicapping conditions. After you have received the assessment information and understand it you are ready for Step Two.

Step Two, developing (or completing) the vocational aspects of the Individual Education Plan-IEP, is usually performed for handicapped students only; however, it has just as much merit for the disadvantaged. The IEP is a very useful tool. It should be considered the description of what you expect that student to be able to do when he or she completes your course and how you will provide the learning experiences to assure that those expected outcomes will be achieved. Be sure that you keep this IEP in a convenient place and use it.

The IEP is usually developed through group activities called staffings. Staffings may be held as often as needed and can be used to modify the IEP as the student moves through the program. When a student is about to be mainstreamed into your curriculum, you must become involved in the staffing sessions that will develop the vocational aspects of the IEP. IT IS YOUR RIGHT AND YOUR DUTY, therefore, your being present during the staffings is imperative. The special education personnel can present the student's interests, strengths and limitations. However, only you, the vocational instructor, can relate these to your program. This means that the final statement of the job (DOT) and the task level (short term) objectives are primarily defined by you the vocational instructor.

In Step Three the IEP will first be used to suggest how the curriculum and/or the facilities can be modified to accommodate the special needs population student. Modifying the curriculum means that in most cases special adjustments will have to be made in the student materials and that special instructional strategies will need to be developed. When you say modify the curriculum you are not suggesting that the content be "watered down" - you are proposing alternate ways to teach the proper/required content. REMEMBER! ALL VOCATIONAL EDUCATION PROGRAMS ARE BASED ON REAL JOBS THAT HAVE THEIR OWN TASKS AND STANDARDS. AS FAR AS YOU ARE CONCERNED, YOU HAVE NO POWER TO CHANGE THESE. YOU ALSO CANNOT SUCCESSFULLY CREATE A WHOLE NEW JOB.

Modification of facilities and equipment is a concern when working with the phyically handicapped. Be reminded that by law your school building must already meet requirements of accessibility to all handicapped persons--especially those who are blind or are confined to wheelchairs. Your chief concern is to be sure that your classroom and laboratory will allow the handicapped students to be comfortable and above all to learn. You will also need to make certain modifications that will enable handicapped students to properly and safely use the "tools and equipment of the trade". It is foolish to think that you would have a ready answer for all or any particular one of these physical handicaps--call on the experts. Vocational rehabilitation counselors and other staff have been concentrating on these problems for many years. They should be able to offer a number of positive suggestions. A combination of VR experience and instructor creativity can and has produced outstanding results.

As we think about curriculum modification it would help to review some general learning needs of this population.

> The educationally mentally retarded will constitute a major population now entering vocational education. The key concept to remember in modifying the curriculum for this population is that they require much more detail in order to learn and they require a great deal more practice time. All curriculum modifications for these groups should be made by detailing each task or objective into its smallest parts and by providing for more and more practice.
>
> The hearing and visually impaired can be accommodated by common sense and the use of supporting resource personnel. Neither of these groups reads well or learns from reading as a primary mode. This should be accounted for in modifying the curriculum, i.e., larger print, brail and recordings for the blind and captions on visual materials, seating arrangements, use of notes from a classmate, lower reading level textbooks, oral testing and total communications for the deaf.

The orthopedically handicapped usually require attention to facilities and equipment. Beyond that, their learning needs are as varied as those of the normal population. Remember, some of these individuals will actually be highly gifted in their chosen field. Their major needs will be psychological and coping with the school environment.

The disadvantaged are physically and mentally capable of learning, but their background has not allowed them to fully develop the discipline and cognitive skills (i.e., vocabulary, math, etc.) required to master occupational preparation courses. They have also developed an anti-school attitude that complicate many efforts to modify the curriculum for them. Usually their success in the vocational program is contingent on either a good pre-vocational program or a supporting academic program.

Step Four requires that instructional strategies be selected. These strategies may be many and should be varied. They should reflect the best learning technique for a given student and his or her chosen occupation. Some examples of instructional strategies are discussed below.

Teacher demonstration: Simply show the student how the job is to be done in clear distinct steps.

Peer demonstration: This technique allows the instructor to use one of the advanced students to demonstrate a particular task in a step by step fashion. It is a flexible system. For example, you can use peer demonstration to show each task step while you explain them to the students. When working with the mentally retarded, you will never have enough time to demonstrate a task as often as they may need to see it. In such situations, the well prepared advanced student can perform and explain the same demonstration several times.

Shadowing: Shadowing can be used in conjunction with demonstrations. By shadowing, the student is allowed to do exactly what the demonstrator does. This allows the student to learn in a see and do fashion. The student may shadow the instructor, an advanced peer or in some instances the worker on the job.

Job site visits: Job site visits offer the student an opportunity to see the work being done in its natural location. Students can develop a worker identify a realistic view of how the tools, equipment and materials are brought together to produce the product.

Work group or team: By being a part of a work team, the student can learn the various roles in an occupation as having the opportunity to practice specific sets of skills under the tutelage of peers.

Individualized instruction: Appropriately prepared or adjusted individualized instruction is a big help in managing a class that contains a mixture of special needs population students and "norm group" students. Individualized instruction, no matter what the source, will require much developmental input from the instructor. In most all cases, however, the results are worth the effort.

Media: Many of the special needs populations require mediated instruction (i.e., hearing and visually impaired), however, the use of appropriate media enhances learning for all students. Media can range from a line drawing in an instructional module, to a video tape, to posters and charts. It can be instructor made or commercial. All that matters is that it exactly links to the objective.

Project Method: The value in using projects with special needs population students is that they help them mentally and physically unify all the parts into a uniform whole. Because of the detail required for them to learn, they need learning activities that relate all of the parts to the whole. The development of a product through an assigned project is an ideal integrating experience.

Simulations: Simulations meet a variety of instructional needs. One of the more important with special needs population students is providing the opportunity to develop proper safety concepts before actually working with the "live" equipment that could be dangerous to a careless student.

Role playing: Role playing is a part of several other instructional strategies. On its own, it is a very good procedure for developing the attitudes and values required of a successful worker-i.e., a sense of responsibility, the ability to take orders and follow directions, interpersonal skills and so on. It is a way to concentrate on developing good work habits and positive attitudes.

Peer instruction: Like peer demonstrations, peer instruction is able to multiply the instructor's available time. This allows individual students with specific needs to have more assistance. Peer instruction has values beyond expanding time; it is an excellent approach to learning. In almost every situation, both the peer teacher and the peer student profit from the exchange. In operation peer instruction is simply a matter of preparing and allowing one of the advanced students to teach small groups certain segments of a course.

Team teaching: As we have already noted, some special needs populations require a combination of vocational and special education presented in harmony. A team approach is the only way to meet that need. For team teaching to be effective, clarification of student needs (as defined by the IEP) and careful planning will be required.

Peer apprenticeships: The peer apprenticeship is an ideal way to induct the new special needs population student into the curriculum. By serving as the apprentice to an advanced student, the special needs population student can become climatized to the laboratory/shop and can begin to learn the tools, equipment and materials of the program. The shadow technique can also be added to increase hands-on learning.

Assessment and feedback: Student learning can be improved by frequently assessing students' skills and feeding back their strengths and weaknesses. Through a process of positive feedback, the student can be moved gradually from where he or she is to the level of skill required.

These instructional strategies can be used independently or in various combinations. This brief list is meant only to provide you with some suggestions, there are no doubt many other techniques that could be used. The creative instructor will be constantly innovating to meet the needs of particular students.

## Implementing the IEP

Step Five is a matter of putting the vocational aspects of the IEP into operation. The activation of the IEP initiates the student into the vocational education program and allows him or her to progress through the modified curriculum at his or her optium rate. There should be frequent assessment activities that indicate where the student is relative to the IEP objectives. If problems are detected, a staffing should be conducted to re-evaluate the IEP and continue the process in a fashion that is most beneficial to the student.

Step Six will take the student to his or her next logical step of either totally exiting the system or recycling into a continuing education mode. In most cases, the student will do some of both--getting a job and periodically accessing the continuing education component of the educational system to refine existing skills or to broaden his or her capacity.

The ultimate goal of all this effort is not employment-rather it is "successful employment". Successful employment implies that not only is the student placed in a job, but that the student is able to sustain himself or herself in a working environment over an extended period of time.

## Evaluation

Evaluation of the student's program is a critical step. Through that process we not only help the current student, but we are able to gather information that will improve our potential to help students with similar difficulties in the future. A well rounded evaluation system should consist of the following activities:

-En-route evaluation (formative) to monitor the student's progress through the program.

-Summative evaluation upon completion of the program to determine job readiness.

-Follow-up after placement to determine if the student is successful on the job.

-Follow-through activities designed to identify any further training needed, which may be indicated by the follow-up procedure.

## RESOURCES

In recent years, mainstreaming of special needs population students has been an area of great concern to vocational educators. The overall result of that concern is an abundance of well developed resource materials and a variety of personnel with special skills in working with these groups. In the space allowed by this curriculum guide, it would be impossible to present an adequate set of methods and procedures for solving the problems of students with special needs, but if the vocational eduction administrator and instructor will judiciously use the human and material resources listed here, much of the in-depth information required for the special and unique cases that will occur can be compiled from these sources.

## Support Personnel or Systems

As was noted earlier, you the vocational instructor, simply do not have sufficient skills to work with special needs population students alone. There are too many different student problems to ever allow an instructor to deal with them all on a "come as you are" basis. For that reason, you must make yourself aware of the variety of support systems and personnel that are available to you and to the students. A few of these are listed here. These specialists can lead you to others on an as needed basis.

County Health Department - Many of your special needs population students will need some medical and dental assistance. The county health facility is an excellent referral source for these problems.

Special Education - Through local boards of education there are a variety of special education personnel available locally, regionally and from the State Department of Education. The vocational education administrator can obtain assistance from these specialists through the local superintendent's office.

Project SERVE - Project SERVE is a statewide effort to acquire materials and to cultivate expertise in providing vocational education to disadvantaged. Project Serve can be contacted by the area vocational-technical director or the vocational supervisor.

Vocational Rehabilitation - Vocational rehabilitation is a highly developed organization whose major focus is all dimensions (such as: diagnosing, training, job placement and counseling) of the handicapped population. Within that network is a vast pool of expertise. You can contact it through the area vocational rehabilitation counselor who calls on your school or through a designated school official such as the coordinator of student personnel services or Career Development Center personnel.

Office of Student Personnel Services - In the area vocational-technical school, this is the key group as far as students and student needs are concerned. They can provide a variety of services to you and to your students. Many of the contacts with community agencies have already been made by this group-that alone will save the instructor much time.

Career Development Center - Each area vocational-technical school has a Career Development Center designed to meet the very special needs of incoming disadvantaged and handicapped students. The CDC staff is available to assist the instructional staff with a wide range of services for the special needs student populations.

All of the resources and resource personnel listed here are a part of the team. The best results can be obtained by using as many of these people and their support systems as possible from the beginning. In some situations, you will miss a resource in the beginning or the student's needs change. When that occurs do not hesitate to call on the appropriate experts for additional help. As a matter of fact, the rule of thumb that has always been used in the "helping professions" is to go as far as you can, then refer. Do not hesitate to call for help. Most of these service groups are funded to support "your" student. If you do not use them, they fail in their mission and you fail in yours.

## Related Materials

Sarkees, M. and Scott, J. Trade and Industrial Education/Vocational Special Needs. Alsip, Illinois: American Technical Publishers, 1981.

### Mentally Retarded

A Curriculum Guide for Teachers of Educable Mentally Retarded. Danville, Ill.: The Interstate Printers and Publishing Co., Inc.

High, Elizabeth C., and Moyers, Kathy L. Training Manual: Developing Pre-Vocational/Vocational Skills in Developmentally Disabled Persons. Washington, D.C.: Job Development Laboratory, George Washington University, 1976.

Kolstoe, Oliver P. Teaching Educable Mentally Retarded Children. Holt, Rinehart and Winston, 1976.

Mulligan, Robert E., Gavin, Donald and Conaley, James. Comprehensive Career Education Curriculum Guide for the Trainable. New Brunswick, N.J.: Rutgers Vocational-Technical Curriculum Laboratory, 1977.

Introduction to Vocations for Educable Mentally Retarded. New Jersey: New Jersey Department of Education.

State of Ohio Curriculum Guide for Moderately Retarded Learners. Columbus, Ohio: Ohio Department of Education, 1977.

Tucker, Mark M. Learning through Curriculum Modification: A Blueprint to Teaching the Mentally Retarded. Johnstown, Pa.: Mafex Associates, Inc., 1976.

Watson, Marjorie. Mainstreaming the Educable Mentally Retarded. Washington, D.C., NEA, 1975.

### Hearing Impaired

Alvin, Howard P. The Evolution of an Evaluation Design for Evaluating Secondary Programs for the Deaf in Vocational Occupational-Technical Education (VOTE) Programs. ERIC ED 123-241.

Guidelines: Educational Planning for the Hearing Handicapped. North Carolina Public Schools. Division for Exceptional Children, North Carolina Department of Public Instruction, Raleigh, N.C., 1977.

Munson, Harold L., Eglston, Judy Cobb and Phillips, Gordon B. Career Education for Deaf Students: An In-Service Leader's Guide. University of Rochester, College of

Education, Center for the Study of Helping Services, Rochester, N.Y., 1975.

Nix, Gary W. *Mainstreaming Education for Hearing Impaired Children and Youth*. Grune and Stratton, 1976.

### Visually Impaired

Coker, D.G. The Development of a Vocational Program in a Residential School for the Visually Handicapped. *The New Outlook for the Blind*, 1974, *68*, pp. 25-28.

*The Current Status of Prevocational Services for the Deaf-Blind Through the Regional Center Program*. Austin, Texas: Management Services Associates, 1976.

Employment Counseling. In: Routh, T.A. *Rehabilitation Counseling of the Blind*, Springfield, Ill.: Charles C. Thomas, 1970.

Rossi, C., Jr., and Marrotta, M. Breaking Blind Sterotypes. *The New Outlook for the Blind*, 1974, *68*, pp. 29-32.

Ruffino, C.R., and Canterbury, C. E. The Visually Handicapped in the Environment. *School Shop*, 1978, *37*, pp. 70-77.

Tremble, J.T., and Campbell, L.F. A Diversified Cooperative Work-Experience Program for Blind and Multiply Handicapped Blind Students. *The New Outlook for the Blind*, 1973, *67*, pp. 216-220.

Wilson, E.L. Assessing the Readiness of Blind Persons for Vocational Placement. *The New Outlook for the Blind*, 1974, *68*, pp. 57-60.

### Orthopedically and Other Health

*A Model Plan for a Cooperative Vocational Rehabilitation Program*. Office of Human Development, Rehabilitation Services and Welfare, Washington, D.C.

Malliz, Kalisanker and Mueller, Jim. *Vocational Aids and Enhanced Productivity of the Severely Disabled*. The George Washington University Rehabilitation Research and Training Center, Washington, D.C., 1975.

McCarthy, Henry and Smart, Landon. *Recommendations for Enhancing Employment Prospects of Handicapped Individuals*. Comps. Human Resources Center, Albertson, L.I., 1978.

Duncan, John, et al. *Environmental Modifications for the Visually Impaired: A Handbook*. Visual Impairment and Blindness, December 1977, p. 442-455.

## Disadvantaged

Guidelines for Methods and Techniques of Teaching Disadvantaged Students. Division of Vocational Education, Virginia Polytechnic Institute and State University, Blacksburg, VA.

A Handbook for Developing Programs and Services for Disadvantaged Students. Department of Vocational Education Studies, College of Education, Southern Illinois, University of Carbondale, Carbondale, Ill.

Knapper, C., Project SERVE. Athens, Ga.: Project SERVE Athens Satallite Center, ND.

Van House, P. and Leatherwood, M. Working with the Disadvantaged Student in Vocational Education. Clarkston, Ga.: Project SERVE DeKalb Satellite Center, ND.

Clowers, M.R., and Stolow, W.C. Handbook of Server Disabilities. Washington, D.C.: U.S. Government Printing Office, 1981.

## By Program

Adaption of Home Economics Curricula for Special Needs. North Dakota Research Ccordination Unit, State Board of Vocational Education, State Office Building, Bismarck, ND.

Auto Body: An Adaptive and Developmental Program for Special Needs Students. Vocational-Technical Curriculum Laboratory, Rutgers - The State University, New Brunswick, N.J., 1976.

Floriculture. Board of Cooperative Education Services of Nassaw County, Division of Occupational Education, Division of Special Education, Westburg, N.Y., 1975.

Grubb, Francine. Basic Business - A Teacher's Guide to an Employment Orientation Course for Special Needs Students. Vocational Technical Curriculum Laboratory, Rutgers - The State University, New Brunswick, N.J., 1976.

Home Economics and the Exceptional Student: A Handbook for Home Economics Teachers Working with Mentally Retarded Students. Vocational-Technical Curriculum Laboratory, Rutgers - The State University, New Brunswick, N.J., 1976.

Troutman, Carol M. Introduction to Office Occupations. Vocational-Technical Curriculum Laboratory, Rutgers - The State University, New Brunswick, N.J., 1974.

Working with the Handicapped in the Vocational Home Economics Classroom. Division of Vocational Education, State of Ohio, Columbus, Ohio.

*Coordinated Vocational Education and Training (C.V.E.T.)* manuals for disadvantaged, available from: Oklahoma State Department of Vocational and Technical Education, Curriculum and Instruction Materials Center, 1515 West Sixth Avenue, Stillwater, Oklahoma 74074.

| | | |
|---|---|---|
| -CVET Construction | 3100219 | Teacher's Guide |
| | 3100209 | Student |
| -CVET General Mechanics | 3100219 | Teacher's Guide |
| | 3100229 | Student |

## General Special Needs

*A Handbook for Modifying Vocational Curricula for Handicapped Students*. Wisconsin Vocational Studies Center, University of Wisconsin, Madison, May 1980.

Bottoms, J.E. and Scott, C.P. Supportive services for special student groups. In J.E. Wall (ed.), *Vocational Education for Special Groups*. Sixth Yearbook, Washington, D.C.: American Vocational Association, 1976.

Gill, Douglas H. and Scott, C. Paul. A practical model for mainstreaming handicapped learners in vocational education. *The Journal for Vocational Special Needs Education*, Vol. 1, No. 3, April, 1979, pp. 3-7.

Gugerty, J., et al. *Tools, Equipment and Machinery Adapted for the Vocational Educator and Employment of the Handicapped*. Project #498749006, Wisconsin Vocational Studies Center, Madison, Wisconsin, January 1981.

Hull, Marc E., Berry, Owen, J. and Clark, Donald L. *Procedures for Teaching Vocational Concepts to Students with Special Needs*. Texas A & M University, Final Report Project 62350274, June 1976.

*The Related Vocational Instruction Program*. Georgia's Approach to Vocational Education for the Handicapped at the Secondary Level, Douglas H. Gill, Project Coordinator, Vocational Programs for the Handicapped, Georgia Southern College, Statesboro, Georgia.

*Vocational Educational Resource Materials, A Bibliography of Materials for Handicapped and Special Education*. Third edition, 1978. Wisconsin Vocational Studies Center, University of Wisconsin - Madison.

# APPENDIX C

## Definition of Terms

## DEFINITION OF TERMS

1. A/Vs-Audiovisuals - May refer to any picture and/or sound media. (ie. slides, tapes, filmstrips, 16 mm films, etc.)

2. Checkpoint - A student-instructor interface point wherein the instructor may give the student a test, perform a demonstration, or simply provide the student with additional needed information or instructions. Also a checkpoint may be used for motivational purposes.

3. Competency - The ability (knowledge, skills and attitudes) to perform all of a group or cluster of related tasks required to complete a designated activity according to occupational standards. In the educational setting, the statement of a competency includes expected student outcomes in terms of knowledge, skills and attitudes required to complete a designated activity as defined by incumbent workers according to the standards of the work place.

4. Course - A grouping of tasks and competencies which have a common knowledge base or are within a given domain.

5. Criterion-Referenced Measure - An exercise based upon a performance objective, the accomplishment of which measures attainment of that objective.

6. Criterion-Referenced Test - A test designed to measure student competencies based on job or industrial standards.

7. Curriculum Guide - A document containing the objectives, content, organization and structure of an instructional program. It is designed for use by administrators, instructional supervisors and teachers.

8. D.O.T. - Abbreviation for Dictionary of Occupational Titles. Document provides nine digit codes identifying each occupation.

9. Duty - One of the distinct major activities involved in the work performed. A Composition of related tasks.

10. Exit Point - A pre-determined point within an instructional program in which a student may exit with the essential competencies for a specific job. Usually defined in terms of D.O.T. codes and/or O.E. codes.

11. "Hands-On" - Statement implying the student is physically involved in a learning activity.

12. Individualized Instruction (I.I.) - A system of instruction allowing a student to progress at his/her fastest rate.

13. Job - A specific area of specialization within an occupational field consisting of several closely related duties for which a person would expect to receive remuneration. Should be identified by DOT code.

14. Job Sheet - (Or Operations Sheet) - A project of a performance nature. Generally performed by the student in a lab or shop type environment or in a specialized work area.

15. Live Work - Generally refers to items brought into the course area for repair or adjustment. Examples of live work might be automobiles, radios and TV's, air-conditioners, etc. Another form of live work would be patrons visiting the cosmetology department to receive permanents or other services.

16. Master Copies - Original copies of slides, tapes or written materials set aside for the purpose of duplication.

17. Occupational Cluster - A group of occupations sharing a common core of competencies. Georgia's comprehensive high school vocational program is organized around this concept.

18. Occupational Inventory - A listing of tasks to be performed in a particular occupational area, grouped under duty classifications.

19. O.E. - Refers to the U.S. Office of Education. O.E. codes are a classification system (taxonomy) for occupational education programs.

20. Open Entry - Term meaning that a student may enter the program at any time and does not have to wait for quarter or semester breaks.

21. Open Exit - Term meaning that a student may leave a program any time he/she completes occupational objectives.

22. Performance Guide - A series of steps arranged in a sequence which when completed may result in the performance of a task. Also called teaching steps.

23. Performance Objective - A statement in precise, measurable terms of a particular behavior to be exhibited by a learner underspecified conditions. It possesses each of the elements or characteristics specified below:

    a. Condition - The testing situation confronting the learner is clearly specified. This includes equipment provided or withheld, environmental constraints such as temperature, space, etc.

b. Performance - The specific behavior expected of the learner is stated.

c. Standard - The degree of acceptable performance is specified.

24. Performance Test - A test entailing not only the ability to answer questions, but measuring the student ability to operate, manipulate or perform a given task.

25. Program - An organized sequence of courses leading to an occupational objective. A program may contain one or more student exit points as defined by D.O.T. codes.

26. Program Objective - The outcome of a prescribed program of instruction. Usually expressed in terms of the occupation or job for which training is designed. D.O.T. codes are frequently used to identify program objectives or student exit points.

27. Self-Paced - Refers to a student moving through the prescribed training program at the fastest pace at which he/she can meaningfully learn.

28. Sequencing - Putting any set or series of learning activities or tasks into proper order or sequence. Normally arranged from simple to complex within groupings or blocks.

29. Software - Written or printed materials, slides, filmstrips, tapes, etc.

30. Student Manual - A document designed for use by students in a specific instructional program. It contains unit sheets, references, operational procedures, job sheets, etc.

31. Task - The smallest division of work in which a measurable output occurs. A logical and necessary step in the performance of a duty.

32. Task List - A listing of tasks performed by incumbent workers within a domain of interest. An example is a listing of all tasks performed by an automotive mechanic or by a worker in ornamental horticulture.

33. Unit - One "module" training material that generally covers one learning task and programmed on one unit sheet. May cover more than one lesson.

34. Unit Guide - A curriculum guide sheet that lists a task and objective with the instructional activities,instructional materials, evaluation and approximate time required for a student to successfully complete the task.

35. V'TECS Catalog - A comprehensive collection of performance objectives, performance guides, criterion-referenced measures and related data. Organized by a job structure or career ladder within a domain of interest.

*Federal law prohibits discrimination on the basis of race, color or national origin (Title VI of the Civil Rights Act of 1964); sex (Title IX of the Educational Amendments of 1972 and Title II of the Vocational Education Amendments of 1976); or handicap (Section 504 of the Rehabilitation Act of 1973) in educational programs or activities receiving federal financial assistance.*

*Employees, students and the general public are hereby notified that the Georgia Department of Education does not discriminate in any educational programs or activities or in employment policies.*

*The following individuals have been designated as the employees responsible for coordinating the department's effort to implement this nondiscriminatory policy.*

*Title II - Loydia Webber, Vocational Equity Coordinator*
*Title VI - Peyton Williams Jr., Associate Superintendent*
*of State Schools and Special Services*
*Title IX - Evelyn Rowe and Myra Tolbert, Coordinators*
*Section 504 - Jane Lee, Coordinator of Special Education*

*Inquiries concerning the application of Title II, Title VI, Title IX or Section 504 to the policies and practices of the department may be addressed to the persons listed above at the Georgia Department of Education, State Office Building, Atlanta 30334; to the Regional Office for Civil Rights, Atlanta 30323; or to the Director, Office for Civil Rights, Education Department, Washington, D.C. 20201.*